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AN INVENTORY OF AERONAUTICAL GROUND RESEARCH
FACILITIES. VOLUME 1: WIND TUNNELS.

McDonnell Aircraft Company
Moffet Field, CA

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PREFACE

McDonnell Aircraft Company has conducted an inventory of Aeronautical Ground Research Facilities under contract number NAS 2-5458 (Modification 1) for NASA's Advanced Concepts and Missions Division, Office of Advanced Research and Technology (OART) located at Ames Research Center, Moffett Field, California. The inventory is intended to provide sufficient documented facility information to be used by government and industry engineers and scientific personnel for planning test programs relative to advanced aeronautical systems. The inventory is arranged by major facility category in four volumes for convenience.

Volume I - Wind Tunnels
Volume II - Airbreathing Engine Test Facilities
Volume III - Structural and Environmental Facilities
Volume IV - Engineering Flight Simulation Facilities

The primary content of each volume is a compilation of facility data pages which provide information descriptive of the general arrangement, performance, testing capability; and where available, acquisition and operating costs of each facility inventoried. Also, sufficient additional source references are provided for those requiring more detailed information. Summary tables in each volume list facilities by type and alphabetically by reporting installation along with brief data descriptive of the facility. An index of facilities is provided which is arranged alphabetically by reporting installation and functional name of each facility under the installation's cognizance.

This inventory was accomplished in five (5) basic steps which included: (1) a literature search to identify candidate facilities, (2) formulation and distribution of appropriate questionnaires to facility operators, (3) preparation of preliminary facility data pages (based on completed questionnaires), (4) operator review of facility data pages to insure accuracy, and (5) final draft of the report.

The facilities included in this inventory do not necessarily represent the total ground research capability of each reporting installation but rather its major capabilities. These facilities were chosen on the basis of several factors such as size, operating range, and uniqueness.

VOLUME I - ABSTRACT

WIND TUNNELS

This volume of the Aeronautical Ground Research Facilities Inventory presents brief descriptive data on subsonic ($M = 0-.99$), transonic ($M = .5-1.4$), supersonic ($M = 1.4-5$) and hypersonic ($M > 5$) wind tunnels. Coverage of these facilities was size limited. In general, subsonic wind tunnels having test sections greater than 5 ft x 5 ft were included, as well as transonic/supersonic tunnels greater than 2 ft x 2 ft and hypersonic tunnels greater than 1 ft x 1 ft. There were, however, a few facilities included which did not strictly adhere to these minimum sizes. These tunnels were either of special interest or they represented the major wind tunnel capabilities of the reporting installation.

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B. SUMMARY TABLES

B.1. SUBSONIC WIND TUNNELS (Government Owned)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility, Type of Throat	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
AFFDL Wright-Patterson AFB, Ohio Vertical Wind Tunnel	Annular return, continuous flow, open throat	12Dx12L	0-.14	0-.91	Ambient	0-26	1-2
AFIT Wright Patterson AFB Ohio 5-Foot Subsonic Wind Tunnel	Open circuit, non-return, continuous flow	5 diameter x 18L	0-.35	.02-3	555	.5-100	1-4
NASA Ames Moffett Field, Calif. 40-Foot by 80-Foot Subsonic Wind Tunnel	Closed circuit, single return, continuous flow, closed throat	40Hx80W	0-.3	0-2.1	Ambient- 600	0-138	1-28
NASA Ames Moffett Field, Calif. 7-Foot by 10-Foot Subsonic Wind Tunnel No. 1	Closed circuit, single return, continuous flow, closed throat	7Hx10Wx15L	0-.33	0-2.3	Ambient	0-210	1-30
NASA Ames Moffett Field, Calif. 7-Foot by 10-Foot Subsonic Wind Tunnel No. 2	Closed circuit, single return, continuous flow, closed throat	7Hx10Wx15L	0-.34	0-2.4	Ambient	0-172	1-32
NASA Ames Moffett Field, Calif. 12-Foot Pressure Tunnel	Closed circuit, single return, variable density, closed throat	11.3 diam x18L	0-.98	0-9	500-625	50-600	1-34
NASA Langley Hampton, Virginia Full Scale Tunnel	Closed circuit, double return, continuous flow, open throat	30Hx60Wx56L	25-110mph	0-1	Ambient	0-30	1-36
NASA Langley Hampton, Virginia V/STOL Transition Research Wind Tunnel	Closed circuit, single return, continuous flow, closed throat	14.5Hx21.75Wx50L	0-.32	0-.55	Ambient	0-135	1-38
NASA Langley Hampton, Virginia High Speed 7 by 10-Foot Tunnel	Closed circuit, single return, continuous flow, closed throat	6.6Hx9.6Wx10L	.2-.9	.1-3.2	490-620	200-750	1-40
NASA Langley Hampton, Virginia Low-Turbulence Pressure Tunnel	Closed circuit, single return, continuous flow, closed throat	7.5Hx3Wx7.2L	.1-.4	.6-15	520-560	23-785	1-42
NASA Langley Hampton, Virginia Spin Tunnel	Annular return, continuous flow, closed throat	25Hx20W	0-90ft/sec	0-.62	Ambient	0-10	1-44
NASA Lewis Cleveland, Ohio Icing Research Tunnel	Closed circuit, single return, continuous flow, closed throat	6Hx9Wx20L	0-.55	0-3.3	456-540	0-230	1-46

B.1. SUBSONIC WIND TUNNELS (Government Owned) (Continued)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility, Type of Throat	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
National Bureau of Standards Gaithersburg, Maryland Dual Test Section Subsonic Wind Tunnel	Closed circuit, single return, continuous flow, closed throat	4Hx5Wx8L; 7Hx5Wx40L	0-.2 0-.15	0-1.6 0-1	550 550	0-74 0-27	1-48
NSRDC Washington, D.C. 8-Foot by 10-Foot Subsonic Wind Tunnel Nos. 1 and 2	Closed circuit, single return, continuous flow, closed throat, tandem V/STOL Section	8Hx10Wx14.2L Tunnel No. 2 has a 17x20 tandem V/STOL section	0-.29 0-.25	0-1.77 0-1.54	576 576	0-90 0-70	1-50

B.1. SUBSONIC WIND TUNNELS (Industry Owned)

Organization Location Facility Name INDUSTRY OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
The Boeing Company Philadelphia, Pa. V/STOL Wind Tunnel	Closed circuit, single return, continuous flow, V/STOL tunnel	20Hx20Wx45L Closed 20Hx20Wx23L Open 20Hx20Wx45L Slotted	0-.4	0-2.5	510-660	0-230	1-6
The Boeing Company Seattle, Washington 9-Foot by 9-Foot Low Speed Wind Tunnel	Open circuit, non-return, continuous flow	9Hx9Wx14.5L	0-.36	0-2.26	Ambient	0-127	1-8
The Boeing Company Seattle, Washington Low Speed Research Tunnel	Closed circuit, single return, continuous flow	8Hx3Wx20L	.025-.3	0-2	480-600	1-140	1-10
General Dynamics Corp. Convair Division San Diego, California 8-Foot by 12-Foot Subsonic Wind Tunnel (With Tandem V/STOL)	Closed circuit, single return, continuous flow, tandem V/STOL	8Hx12Wx15L, V/STOL-16Hx20Wx 24L	.04-.37 .02-.08	.25-2.5 .1-.55	Ambient Ambient	2-200 .5-10	1-14
Grumman Aerospace Corp. Bethpage, L.I., New York 7-Foot by 10-Foot Subsonic Wind Tunnel	Open circuit, open return, continuous flow	7Hx10Wx20L	0-.18	0-1.7	Ambient	0-46	1-18
LTV Aerospace Corp. Dallas, Texas 7-Foot by 10-Foot and 15-Foot by 20-Foot Subsonic Wind Tunnel	Closed circuit, single return, continuous flow, tandem V/STOL	7Hx10Wx16L V/STOL-15Hx20Wx 39L	.3-.36 .0063-.069	.26-2.17 .058-.49	Amb.+20°F Amb.+20°F	2-135 .5-7	1-20
Lockheed-California Burbank, California 8-Foot by 12-Foot Subsonic Wind Tunnel	Closed circuit, single return, continuous flow	8Hx12Wx15L	0-.25	0-1.5	Ambient	0-120	1-22
Lockheed-Georgia Marietta, Georgia Low Speed Wind Tunnel	Closed circuit, single return, continuous flow, tandem V/STOL	16.25Hx23.25Wx43L V/STOL-30Hx26Wx 63L	.04-.32 .02-.16	.3-2 .15-1	570 570	2-160 .5-40	1-24
McDonnell Douglas Corp. St. Louis, Missouri Low Speed Wind Tunnel	Closed circuit, single return, continuous flow	8.5Hx12Wx18L	0-.3	.2-2	570	10-125	1-26
North American Rockwell Corporation Columbus, Ohio Subsonic Wind Tunnel With Tandem V/STOL Section	Closed circuit, single return, continuous flow, tandem V/STOL	7Hx10Wx15L 16Hx14Wx15L	0-.37 20-85mph	0-2.8 0-.85	Ambient Ambient	10-200 1-18	1-52
North American Rockwell Corporation Los Angeles, Calif. Low Speed Wind Tunnel	Closed circuit, single return, continuous flow	7.75Hx11Wx12L	0-.28	0-2	570	0-120	1-54

B.1. SUBSONIC WIND TUNNELS (Industry Owned) (Continued)

Organization Location Facility Name INDUSTRY OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
Northrop Corporation Hawthorne, California 7-Foot by 10-Foot Subsonic Wind Tunnel	Closed circuit, single return, continuous flow	7Hx10Wx20L	0-.37	.4-2	540-580	0-200	1-56
United Aircraft Research Laboratories East Hartford, Conn. Acoustic Research Tunnel	Open circuit, non-return, continuous flow	2.5 to 4.5H x 2.5 to 4.5Wx4L	600 ft/sec	Not Available	Ambient	Not Available	1-60
United Aircraft Research Laboratories East Hartford, Conn. 4-Foot by 6-Foot Subsonic Wind Tunnel	Closed circuit, single return, continuous flow	4Hx6Wx6L	0-.14	0-.8	520-590	5-31	1-62
United Aircraft Research Laboratories 8-Foot Subsonic/ Transonic Wind Tunnel	Closed circuit, single return, continuous flow	8 octagonal x18L	0-1.17	1.2-4.5	529-610	0-860	2-78

B.1. SUBSONIC WIND TUNNELS (University Owned)

Organization Location Facility Name	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
UNIVERSITY OWNED							
GALCIT Pasadena, California 10-Foot Subsonic Wind Tunnel	Closed circuit, single return, continuous flow	10 diameter x 10L	.03-.22	.16-1.41	500-580	1-72	1-12
Georgia Institute of Technology Atlanta, Georgia 9-Foot Subsonic Wind Tunnel	Closed circuit, single return, continuous flow	9 diameter	0-.27	0-1.6	590	0-57	1-16
Texas A&M College Station, Texas 7-Foot by 10-Foot Subsonic Wind Tunnel	Closed circuit, single return, continuous flow	7Hx10Wx16L	0-.25	0-1.9	Ambient	0-100	1-58
University of Maryland College Park, Maryland Subsonic Wind Tunnel	Closed circuit, single return, continuous flow	7.75Hx11Wx15L	0-.32	0-2.06	530	0-102.4 (With Model)	1-64
University of Michigan Ann Arbor, Michigan 5-Foot Low Speed Wind Tunnel	Closed circuit, single return, continuous flow	5Hx7Wx25L	0-.26	0-2	Ambient	0-100	1-66
University of Washington Seattle, Washington 8-Foot by 12-Foot Subsonic Wind Tunnel	Closed circuit, double return, continuous flow	8Hx12Wx10L	0-.27	0-1.8	Ambient	1-160	1-68
Wichita State University Wichita, Kansas 7-Foot by 10-Foot Subsonic Wind Tunnel	Closed circuit, single return, continuous flow	7Hx10Wx12L	0-.3	0-1.6	Ambient	0-90	1-70

B.2. TRANSONIC WIND TUNNELS (Government Owned)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
AEDC Arnold AFS, Tennessee Propulsion Wind Tunnel (16-Foot Transonic 16T)	Closed circuit, single return, variable density, continuous flow	Two test carts 16Hx16Wx40L	.2-1.6	.1-7.5	410-620	3.3-1300	2-2
AEDC Arnold AFS, Tennessee Propulsion Wind Tunnel Facility (PWT) (4-Foot Transonic 4T)	Closed circuit, single return, variable density, continuous flow	4Hx4Wx12.5L	Not Available	Not Available	Not Available	Not Available	2-2
NASA Ames Moffett Field, Calif. 14-Foot Transonic Wind Tunnel	Closed circuit, single return, atmospheric continuous flow	13.5Hx13.9Wx 33.75L	.6-1.2	2.8-5.2	500-640	425-885	2-36
NASA Ames Moffett Field, Calif. 11-Foot Transonic Wind Tunnel (Unitary)	Closed circuit, single return, variable density, continuous flow	11Hx11Wx22L	.5-1.4	1.7-9.4	540-610	150-2000	2-34
NASA Ames Moffett Field, Calif. 2-Foot by 2-Foot Transonic Wind Tunnel	Closed circuit, single return, variable density, continuous flow	2Hx2Wx5L	.2-1.4	.5-8.7	580	60-2175	2-38
NASA Ames Moffett Field, Calif. 6-Foot by 6-Foot Supersonic Wind Tunnel	Closed circuit, single return, variable density, continuous flow	6Hx6Wx14L	.25 and .6-2.2	.5-5	580 max.	200-1000	2-44
NASA Langley Hampton, Virginia 8-Foot Transonic Pressure Tunnel	Closed circuit, single return, variable density, continuous flow	7.1Hx7.1Wx18L	.2-1.3	.1-6	580	6-1260	2-48
NASA Langley Hampton, Virginia 16-Foot Transonic Tunnel	Closed circuit, single return, atmospheric, continuous flow	15.5 octagonal x 22L	.2-1.3	1.2-3.7	510-640	57-905	2-54
NASA Langley Hampton, Virginia Transonic Dynamics Tunnel	Closed circuit, single return, variable density, continuous flow	16x16x30L Air Freon-12	0-1.2	0-2.9 0-9.7	Ambient to 600	0-320 0-420	2-56
NASA Lewis Cleveland, Ohio 8-Foot by 6-Foot Supersonic Wind Tunnel	Closed or open circuit, single or nonreturn, variable density, continuous flow	8Hx6Wx39L	.8-2.1	4.2-4.8	600-700	650-1240	2-62
NSRDC Washington, D.C. 7-Foot by 10-Foot Transonic Wind Tunnel	Closed circuit, single return, variable density, continuous flow	7Hx10Wx19L	.4-1.17	1-6	610	50-950	2-78

B.2. TRANSONIC WIND TUNNELS (Industry Owned)

Organization Location Facility Name INDUSTRY OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
The Boeing Company Seattle, Washington Transonic Wind Tunnel	Closed circuit, single return, continuous flow	8Hx12Wx14.5L	0-1.2	0-4	540-640	0-900	2-10
The Boeing Company Seattle, Washington 4-Foot Supersonic Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4Wx6.5L	1.2-4	3-24	525	1200-3200	2-12
Cornell Aeronautical Laboratory, Inc. Buffalo, New York 8-Foot Transonic Wind Tunnel	Closed circuit, single return, variable density, continuous flow	8Hx8Wx18.75L	0-1.35	.7-7	560-615	50-800	2-14
Fluidyne Engr. Corp. Minneapolis, Minnesota 66-Inch Transonic Wind Tunnel	Open circuit, open return, induction type	5.5Hx5.5W	0-1	0-4.7	Ambient to just above conden- sation	0-800	2-16
General Dynamics Corp. Convair Division San Diego, California 4-Foot High Speed Wind Tunnel	Intermittent blowdown to atmosphere, flexible nozzle	4Hx4Wx5L	.5-5	5-23	560	1000-2500	2-18
Grumman Aerospace Corp. Easthampton, N. Y. 26-Inch Transonic Wind Tunnel	Intermittent blowdown to atmosphere	2.17 octagonal x 2.5L	.6-1.3	7-29	460	835-4600	2-22
Lockheed-California Burbank, California 4-Foot Trisonic Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4W	.1-5	1-43	570-660	1150-5000	2-24
Lockheed-Georgia Marietta, Georgia Trisonic Wind Tunnel	Blowdown to atmosphere	1.66Hx2.33Wx6L	.3-1.3	3-60	Ambient	Not Available	2-26
LTV Aerospace Corp. Dallas, Texas High Speed Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4Wx5L	.2-5	2-38	560	150-5000	2-28
McDonnell Douglas Corp. El Segundo, California 4-Foot Trisonic Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4Wx17L	.2-5	.25-60	530-645	200-3100	2-30
McDonnell Douglas Corp. St. Louis, Missouri Polysonic Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4Wx9L	.5-5.8	2-50	530-710	250-6500	2-32
North American Rockwell Corp. Columbus, Ohio Supersonic/Transonic Wind Tunnel (TSWT)	Intermittent blowdown to atmosphere	2.17Hx2.17Wx4L	.3-3	1-23	530	100-4000	2-70

B.2. TRANSONIC WIND TUNNELS (Industry Owned) (Continued)

Organization Location Facility Name INDUSTRY OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
North American Rockwell Corp. Los Angeles, Calif. 7-Foot Trisonic Wind Tunnel	Intermittent blowdown to atmosphere	7Hx7Wx23L	.1-3.5	2-17	530	1000-3100	2-72
Northrop Corporation Hawthorne, Calif. 24-Inch Trisonic Wind Tunnel	Intermittent blowdown to atmosphere	2Hx2W	.2-1.35 and 1.5, 2,3	.15-70	Not Available	Not Available	2-74
United Aircraft Research Laboratories East Hartford, Conn. 8-Foot Subsonic/ Transonic Wind Tunnel	Closed circuit, single return, atmospheric, continuous flow	8 octagonal x 18L	0-1.17	1.2-4.5	520-610	0-860	2-80
United Aircraft Research Laboratories East Hartford, Conn. 17-Inch Transonic Wind Tunnel	Intermittent blowdown to atmosphere	1.42Hx1.42Wx1.5L	.5-1.4 and 1.5, 2,2.5	3.5-22.8	540	400-4500	2-82

B.3. SUPERSONIC WIND TUNNELS (Government Owned)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
AEDC Arnold AFS, Tennessee Propulsion Wind Tunnel Facility (PWT) (16-Foot Supersonic 16S)	Closed circuit, single return, variable density, continuous flow	16Hx16Wx40L	1.5-4.75	.1-2.6	560-1110	30-570	2-2
AEDC Arnold AFS, Tennessee Supersonic Wind Tunnel (A)	Closed circuitry, variable density, continuous flow	3.33Hx3.33Wx7L	1.5-6	.3-9.2	530-750	49-1800	2-2
AFFDL Wright-Patterson AFB Ohio 2-Foot Supersonic Gasdynamic Facility	Closed circuit, single return, variable density, continuous flow	2Hx2W	1.5, 1.89, 2.3, 3, 4.76	.1-5.6	559	40-1100	2-4
BRL Aberdeen Proving Ground, Maryland Supersonic Wind Tunnel No. 1	Closed circuit, single return, variable density, continuous flow	1.25Hx1.08W	1.25-5	.5-8.5	540-590	36-1800	2-6
BRL Aberdeen Proving Ground, Maryland Supersonic Wind Tunnel No. 3	Closed circuit, single return, variable density, continuous flow	1.67H to 1.08Hx 1.25W	1.15-4.89	1.4-9	540-590	140-1800	2-8
NASA Ames Moffett Field, Calif. 9-Foot by 7-Foot Supersonic Wind Tunnel (Unitary)	Closed circuit, single return, variable density, continuous flow	9Hx7Wx18L	1.55-2.6	.8-6.5	580	200-	2-40
NASA Ames Moffett Field, Calif. 8-Foot by 7-Foot Supersonic Wind Tunnel (Unitary)	Closed circuit, single return, variable density, continuous flow	8Hx7Wx16L	2.4-3.5	.5-5	580	200-1000	2-42
NASA Ames Moffett Field, Calif. 6-Foot by 6-Foot Supersonic Wind Tunnel	Closed circuit, single return, variable density, continuous flow	6Hx6Wx14L	.25-2.2	.5-5	580 max.	200-1000	2-44
NASA Ames Moffett Field, Calif. 11-Foot by 3-Foot Supersonic Wind Tunnel	Closed circuit, return type, variable density, continuous flow	1.25H to 2.8Hx 1Wx5.5L	.4-.9 and 1.4-6	.5-12	520-600	122-2500	2-46
NASA Langley Hampton, Virginia 4 by 4-Foot Supersonic Pressure Tunnel	Closed circuit, single return, variable density, continuous flow	4.5Hx4.5Wx7L	1.25-2.6	1.4-6.6	570	250-1368	2-50

B.3. SUPERSONIC WIND TUNNELS (Government Owned) (Continued)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (Psf)	Page
NASA Langley Hampton, Virginia 9-Foot by 6-Foot Thermal Structures Tunnel	Intermittent blowdown to atmosphere	8.75Hx6Wx10L Section 1 Hot Core	3 3	2.9-29.2 1.0-4.1	560-1120 2500	1230-4940 1240-4960	2-52
NASA Langley Hampton, Virginia Unitary Plan Wind Tunnel	Closed circuit, single return, variable density, continuous	Two: 4Hx4Wx7L	1.47-2.86 2.29-4.63	.42-10.8 .57-8.1	610 610-635	83-1550 90-1075	2-58
NASA Lewis Cleveland, Ohio 10 by 10-Foot Supersonic Wind Tunnel	Closed or open circuit, single or nonreturn, variable density, continuous flow	10Hx10Wx40L Aerodynamic Propulsion	2-3.5 2-3.5	.12-3.35 2.1-2.68	1160 1160	20-720 500-600	2-60
NASA Lewis Cleveland, Ohio 8 by 6-Foot Supersonic Wind Tunnel	Closed or open circuit, single or nonreturn, variable density continuous flow	8Hx6Wx39L	.8-2.1	4.2-4.8	600-700	650-1240	2-62
NOL Silver Spring, Maryland Supersonic Tunnel No.1	Intermittent blowdown to vacuum	1.33Hx1.33Wx5L	.05-.9 and over transonic to 5	.8-4.6	500-565	0-878	2-64
NOL Silver Spring, Maryland Supersonic Tunnel No.2	Closed circuit, recirculating or blowdown, variable density	1.33Hx1.33Wx8L	1.5-5	.05-38	530-635	72	2-66
NOL Silver Spring, Maryland Boundary Layer Channel	Arc discharge	1Hx1Wx5L	3,5	.03-10	1410	36.3-175	2-68
NSRDC Washington, D.C. 18-Inch by 18-Inch Supersonic Wind Tunnel	Intermittent blowdown to vacuum	1.5Hx1.5Wx2L	.2-.9 and 1.56-4.5	1-5	Ambient	58-805	2-76

B.3. SUPERSONIC WIND TUNNELS (Industry Owned)

Organization Location Facility Name INDUSTRY OWNED	Type of Facility	Test Section Size (Dimensions in feet)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
The Boeing Company Seattle, Washington 4-Foot Supersonic Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4Wx4L and 1Hx3W transonic insert	1.2-4	6-17	525	1200-3200	2-12
General Dynamics Corp. San Diego, California 4-Foot High Speed Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4Wx5L	.5-5	5-23	560	1000-2500	2-18
Grumman Aerospace Corp. Bethpage, L.I., New York 15-Inch Supersonic Wind Tunnel	Intermittent blowdown to atmosphere	1.25Hx1.25Wx1.5L	1.5, 1.75, 2.2, 2.5, 3, 3.5, 4	8.5-65	460	1550-6700	2-20
Lockheed-California Burbank, California 4-Foot Trisonic Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4W	.1-5	1-43	570-660	1150-5000	2-24
LTV Aerospace Corp. Dallas, Texas High Speed Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4Wx5L	.2-5	2-38	560	150-5000	2-28
McDonnell Douglas Corp. El Segundo, California 4-Foot Trisonic Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4Wx17L	.2-5	.25-60	520-685	200-3800	2-30
McDonnell Douglas Corp. St. Louis, Missouri Polysonic Wind Tunnel	Intermittent blowdown to atmosphere	4Hx4Wx9L	.5-5.8	2-50	530-710	250-6500	2-32
North American Rockwell Corporation Columbus, Ohio Supersonic/Transonic Wind Tunnel (TSWT)	Intermittent blowdown to atmosphere	2.17Hx2.17Wx4L	.3-3	1-23	530	100-4000	2-70
North American Rockwell Corporation Los Angeles, Calif. 7-Foot Trisonic Wind Tunnel	Intermittent blowdown to atmosphere	7Hx7Wx23L	.1-3.5	2-17	530	100-3100	2-72
Northrop Corporation Hawthorne, Calif. 24-Inch Trisonic Wind Tunnel	Intermittent blowdown to atmosphere	2Hx2W	.2-1.35 and 1.5, 2, 3	.15-70	Not Available	Not Available	2-74
United Aircraft Research Laboratories East Hartford, Conn. 17-Inch Supersonic Wind Tunnel	Intermittent blowdown to atmosphere	1.42Hx1.42Wx1.42L	1.5-5	7-27.6	550	1000-7500	2-82
United Aircraft Research Laboratories East Hartford, Conn. 17-Inch Transonic Wind Tunnel	Intermittent blowdown to atmosphere	1.42Hx1.42Wx1.5L	.5-1.4 and 1.5, 2, 2.5	3.2-22.8	540	400-4500	2-84

B.4. HYPERSONIC WIND TUNNELS (Government Owned)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in inches)	Mach Range	Reynolds Number Per Ft. $\times 10^{-6}$	Total Temp. (°R)	Dynamic Press. (psf)	Page
AEDC Arnold AFS, Tennessee Hypersonic Wind Tunnel (B)	Closed circuit, recycling, variable density continuous flow	50 diameter	6,8	.3-4.7	850- 1350	43-590	3-2
AEDC Arnold AFS, Tennessee Hypersonic Wind Tunnel (C)	Closed circuit, recycling, variable density continuous flow	50 diameter	10,12	.3-2.2	1910- 2350	43-400	3-2
AEDC Arnold AFS, Tennessee Hypersonic Wind Tunnel (E)	Intermittent blowdown	Not Available	Not Available	Not Available	Not Available	Not Available	3-2
AEDC Arnold AFS, Tennessee Hypervelocity Wind Tunnel (F)	Arc driven	Not Available	Not Available	Not Available	Not Available	Not Available	3-2
AEDC Arnold AFS, Tennessee Hypervelocity Wind Tunnel (H)	Arc driven	Not Available	Not Available	Not Available	Not Available	Not Available	3-2
AEDC Arnold AFS, Tennessee Hypervelocity Research Tunnel (I)	Shock tunnel	Not Available	Not Available	Not Available	Not Available	Not Available	3-2
AEDC Arnold AFS, Tennessee Hypervelocity Research Tunnel (J)	Shock tunnel	Not Available	Not Available	Not Available	Not Available	Not Available	3-2
AEDC Arnold AFS, Tennessee Low Density Hyper- sonic Wind Tunnel (L)	Arc heated, continuous flow	Not Available	Not Available	Not Available	Not Available	Not Available	3-2
AEDC Arnold AFS, Tennessee Low Density Hyper- sonic Tunnel (M)	Arc heated, continuous flow	Not Available	Not Available	Not Available	Not Available	Not Available	3-2
AFAPL Wright Patterson AFB, Ohio Ramjet Research 10-Foot Shock Tunnel	Shock tunnel	40 diameter	8-33	1	5700	Not Available	3-6
AFFDL Wright Patterson AFB, Ohio 50-Megawatt Gasdynamic Facility	Arc heated, continuous flow	96 diameter (maximum main test leg) Re-entry test	5.5- 15 leg also available	.004-.3	6500- 11,300	7-400	3-8

B.4. HYPERSONIC WIND TUNNELS (Government Owned) (Continued)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in inches)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
AFFDL Wright Patterson AFB, Ohio 2-Foot Electrogas- dynamic Facility	Arc heated, continuous flow	19.36 diameter	6-12	.01-.2	To 12,000	30-600	3-10
AFFDL Wright Patterson AFB, Ohio High Temperature Hypersonic Wind Tunnel	Intermittent blowdown to vacuum	32 diameter	8.5-11.5	.017-.7	2500- 4200	.061- 1.571	3-12
ARL Wright Patterson AFB, Ohio 30-Inch Hypersonic Wind Tunnel	Intermittent blowdown to vacuum	30 diameter	16-22	.1-1	3000- 4400	15-25	3-14
ARL Wright Patterson AFB, Ohio 20-Inch Hypersonic Wind Tunnel	Intermittent blowdown to vacuum	20 diameter	12, 14	.25-.8	500- 2500	20-140	3-16
BRL Aberdeen Proving Ground, Maryland Hypersonic Wind Tunnel No. 4	Closed circuit, single return, variable density, continuous flow	15 diameter (nominal)	6,7,5, 9.2	.4-15	860- 1960	115-1700	3-26
NASA Ames Moffett Field, Calif. 42-Inch Shock Tunnel	Shock tunnel	42 diameter	8.5- 27.2	.007-.7	6000- 12,000	4-120	3-60
NASA Ames Moffett Field, Calif. 3.5-Foot Hypersonic Wind Tunnel	Intermittent blowdown to vacuum	42 diameter	5,7,10, 14	.06-8	3460	332- 2550	3-62
NASA Ames Moffett Field, Calif. 20-Inch Hypersonic Helium Tunnel	Intermittent blowdown to vacuum	20 diameter	8,15, 20,26	1-13	610	260- 1960	3-64
NASA Ames Moffett Field, Calif. Hypervelocity Free- Flight Facility	Intermittent	42 diameter	30K ft/sec (model speed)	80	Not Available	Not Available	3-66
NASA Ames Moffett Field, Calif. Prototype Hyper- velocity Free Flight Facility	Intermittent	12 mm model diameter	28K ft/sec (model speed)	80	Not Available	Not Available	3-68
NASA Ames Moffett Field, Calif. 30-Inch Hypersonic Arc Shock Tunnel	Arc heated	30Rx30Wx36L	8.5- 19.7	.002- .045	10,000- 16,500	6-210	3-70

B.4. HYPERSONIC WIND TUNNELS (Government Owned) (Continued)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility	Test Section (Dimensions in inches)	Mach Range	Reynolds Number Per Ft. x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
NASA Ames Moffett Field, Calif. Entry-Aerodynamics Tunnel and Heat- Transfer Tunnel	Two: Arc heated tunnels	24 diameter	2.5-14	.001-5	2500- 15,000	20- 15,000	3-72
NASA Ames Moffett Field, Calif. Mach 50 Helium Wind Tunnel	Intermittent blowdown to vacuum	28 diameter	39-42	.4-1.3	800-2000	50 (approx.)	3-74
NASA JPL Pasadena, California 43-Inch Shock Tunnel	Shock Tunnel	43 diameter	12.5	.042	6080	70	3-76
NASA JPL Pasadena, California 21-Inch Hypersonic Wind Tunnel	Closed circuit, single return, variable density continuous flow	25Hx20Wx70L	4-11.3	.048-9.6	560-1810	12.96-460	3-78
NASA Langley Hampton, Virginia 8-Foot High Temperature Structures Tunnel	Intermittent blowdown to atmosphere	96 diameter	7.1-7.8	.06-3.7 .2-3.75	2500-4000	216-2190	3-80
NASA Langley Hampton, Virginia High Reynolds Number Helium Tunnels	Intermittent blowdown to vacuum	60 diameter 37 diameter	20 10	1.3-18 1.43-57	540 540	69-920 200-6900	3-82
NASA Langley Hampton, Virginia 4-Foot Hypersonic Arc Tunnel	Arc fired	48 diameter & 24 diameter	8-18	.01-1	To 10,000	13-40	3-84
NASA Langley Hampton, Virginia Continuous Flow Hypersonic Tunnel	Intermittent blowdown to vacuum or continuous flow	31Hx31Wx72L	10 11 12	.3-2.25 .3-30 .25-.8	1810-1960 2260-2460 2460-2660	40-400 50-550 85-125	3-86
NASA Langley Hampton, Virginia 22-Inch Helium Tunnel	Intermittent blowdown to vacuum	22.5 diameter	17.6-22.2	.7-11.3	535-866	144-500	3-88
NASA Langley 20-Inch Hypersonic Tunnel (Mach 8.5)	Intermittent blowdown to atmosphere	21 diameter	8.5	1.5-7.5	1500	250-1250	3-90
NASA Langley Hampton, Virginia 20-Inch Hypersonic Tunnel (Mach 6)	Blowdown to atmosphere	20x20	6	.7-9.3	1000	115-1260	3-92
NASA Langley Hampton, Virginia Hypersonic Nitrogen Tunnel	Arc discharge to vacuum	19 diameter	19	.2-1.0	2800- 3500	Not Available	3-94

B.4. HYPERSONIC WIND TUNNELS (Government Owned) (Continued)

Organization Location Facility Name	Type of Facility	Test Section (Dimensions in inches)	Mach Range	Reynolds Number Per Ft. x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
GOVERNMENT OWNED							
NASA Langley Hampton, Virginia Mach 8 Variable- Density Hypersonic Tunnel	Intermittent blowdown to atmosphere or vacuum	18 diameter	7.5-8	.1-12	1160-1510	Not Available	3-96
NASA Langley Hampton, Virginia 1-Foot Hypersonic Arc Tunnel	Arc discharge to atmosphere	12 diameter	11-12	.01-.02	8100	10-14	3-98
NASA Langley Hampton, Virginia Mach 6 High Reynolds Number Tunnel	Blowdown type	12 diameter	6	.1-50	700-1000	168 to 10,080	3-100
NASA Langley Hampton, Virginia 11-Inch Hypersonic Tunnel	Intermittent blowdown to vacuum	11 diameter	6.8,9.6	.3-4	Not Available	Not Available	3-102
NASA Langley Hampton, Virginia Hot Gas Radiation Research Facility	Shock type	6 diameter to 48 diameter	Not Available	Not Available	Not Available	Not Available	3-104
NASA Langley Hampton, Virginia Entry Structures Facility	Four arc- powered apparatus	Specimen diameter: 2 to 3	See data on page				3-106
NASA MSC Houston, Texas 10-Megawatt Arc Tunnel Facility	Arc discharge	96 diameter (5-25 core)	2-8	.001-.1	3000- 20,000	Not Available	3-108

B.4. HYPERSONIC WIND TUNNELS (Government Owned) (Continued)

Organization Location Facility Name GOVERNMENT OWNED	Type of Facility	Test Section Size (Dimensions in inches)	Mach Range	Reynolds Number Per Ft. $\times 10^{-6}$	Total Temp. (°R)	Dynamic Press. (psf)	Page
NASA MSC Houston, Texas 1.5 Megawatt Arc Tunnel Facility	Arc discharge	72 diameter (4 core)	4-5	.0005- .05	23,000	Not Available	3-110
NOL Silver Spring, Md. Hypersonic Wind Tunnel	Intermittent blowdown to atmosphere or exhaust system	18 diameter	5,6,7,8, 9,10,12, 17	.1-50	700- 4000	50- 7000	3-112
NOL Silver Spring, Md. 3-Megawatt Arc Tunnel	Arc discharge	10 diameter test core	1-10	.01-1	2700- 10,800	Not Available	3-114
NSRDC Washington, D.C. 13.5-Inch Hypersonic Wind Tunnel	Intermittent blowdown to vacuum	13.5 diameter	5-10	.07-9	540- 2500	0-430	3-116

B.4. HYPERSONIC WIND TUNNELS (Industry Owned)

Organization Location Facility Name INDUSTRY OWNED	Type of Facility, Type of Nozzle	Test Section Size and Type (Dimensions in inches)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
Aerospace Corp. El Segundo, California Helium Driven Shock Tunnel	Shock tunnel, conical	47 diameter, free jet	14-20	.1-1.2	2700-5000	8-302	3-4
AVCO Systems Division Wilmington, Mass. 20-Inch Shock Tunnel	Shock tunnel, conical	20 diameter	10-18	.04-4	to 5000	Not Available	3-18
AVCO Systems Division Wilmington, Mass. 10-Megawatt Multi-Arc Wind Tunnel	Arc heated, conical	12 diameter, closed jet	5	.001-1	to 14,000	Not Available	3-20
The Boeing Company Seattle, Washington 30-Inch Shock Tunnel	Shock tunnel	30 diameter, free jet	5.2-7; 12-16	.01-10	1000- 14,400	7-180,000	3-22
The Boeing Company Seattle, Washington 12-Inch Hypersonic Wind Tunnel	Intermittent blowdown	12 diameter, free jet	5,6,7	3.4-35	1170-1460	1140-2380	3-24
Cornell Aeronautical Laboratory Buffalo, New York 96-Inch Hypersonic Shock Tunnel	Shock tunnel, four axisymmetric	96 diameter (with 24" to 72" exit diameter nozzles)	6.5-24	.001-75	1300- 11,500	To 20,000	3-28
Cornell Aeronautical Laboratory Buffalo, New York 48-Inch Hypersonic Shock Tunnel	Shock tunnel, conical, contoured	48 diameter (with 24" and 48" exit diam- eter nozzles)	5.5-20	.006-40	1100-5800	To 5750	3-30
Cornell Aeronautical Laboratory Buffalo, New York Wave Superheater Hypersonic Tunnel	Rotating multiple shock tunnel	72 diameter	1-12	.028-4	4000-8000	Not Available	3-32
Fluidyne Engr. Corp. Minneapolis, Minn. 20-Inch Hypersonic Wind Tunnel	Intermittent blowdown to vacuum, contoured	20 diameter, free jet	7-18	.02-20	1200-4000	1.44-1440	3-34
General Dynamics Corp. San Diego, Calif. 18-Inch Hypersonic Wind Tunnel	Intermittent blowdown, contoured	18 diameter, free jet	8,10,12	2.28,1.3, .73	1320-1460	To 2.5	3-36
General Electric Co. Philadelphia, Pa. 54-Inch Shock Tunnel	Shock tunnel, contoured	54 diameter, free jet	9-20	.00001-1	2200-3200	Not Available	3-38
General Electric Co. Philadelphia, Pa. Long Test Time Hypersonic Facility (LTF)	Shock tunnel, contoured	22 diameter, free jet	10-20	.001-20	2500	Not Available	3-40

B.4. HYPERSONIC WIND TUNNELS (Industry Owned) (Continued)

Organization Location Facility Name INDUSTRY OWNED	Type of Facility, Type of Nozzle	Test Section Size and Type (Dimensions in inches)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
Grumman Aerospace Corp Bethpage, L.I., N.Y. 36-Inch Hypersonic Wind Tunnel	Intermittent blowdown to vacuum, contoured	36 diameter, free jet	8,10,14	.2-4.5	1000-3500	100-1200	3-42
Grumman Aerospace Corp Bethpage, L.I., N.Y. Rocket Plume Simula- tion Facility and Low Energy Hypersonic Shock Tunnel	Shock tunnel, geometrically scaled rocket nozzles	18 diameter, free jet	10-15	.04-1	To 3000	Not Available	3-44
KMS Industries, Inc. Canoga Park, Calif. 60-Inch Hypervelocity Tunnel and Impact Test Facility	Arc driven, conical, contoured	60 diameter, free jet	5-40	.0015-150	500- 80,000	Not Available	3-46
LTV Aerospace Corp. Dallas, Texas VAD Hypervelocity Wind Tunnel	Arc fired, contoured	13 diameter, closed jet	12-20	.1-7	2700-8100	16-2000	3-48
Lockheed-California Burbank, California Hypervelocity Shock Tunnel	Shock tunnel	110 diameter, free jet	9-25	Not Available	Not Available	Not Available	3-50
Lockheed-California Burbank, California 30-Inch Hypersonic Wind Tunnel	Intermittent blowdown to exhaust system	30 diameter, free jet	8-10	.0006-1	1260-1660	Not Available	3-52
McDonnell Douglas Corp St. Louis, Missouri Hypervelocity Impulse Tunnel	Arc fired, conical and contoured	44 diameter, free jet	11.5-24	.05-4.3	To 7820	To 1700	3-54
McDonnell Douglas Corp El Segundo, California 30-Inch Hypervelocity Shock Tunnel	Shock tunnel, contoured	30 diameter, closed jet	7-20	.26-130	2000-6000	100- 49,000	3-56
McDonnell Douglas Corp El Segundo, California 2-Foot Hypersonic Wind Tunnel	Intermittent blowdown to vacuum	24 diameter, free jet	6,8,10	1.2-12	850-2470	288-1440	3-58
North American Rockwell Corporation Los Angeles, Calif. 1-Foot Hypersonic Wind Tunnel	Intermittent blowdown to vacuum	12 diameter, test core	3.5,5,7, 9	.1-16	540-1760	15-2000	3-118
Northrop Corporation Hawthorne, California 30-Inch Hypersonic Wind Tunnel	Intermittent blowdown to vacuum	30 diameter, free jet	6,10,14	.02-3.5	To 3200	10-600	3-120

B.4. HYPERSONIC WIND TUNNELS (Industry Owned) (Continued)

Organization Location Facility Name INDUSTRY OWNED	Type of Facility, Type of Nozzle	Test Section Size and Type (Dimensions in inches)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
Sandia Laboratories Sandia Base, New Mexico 18-Inch Hypersonic Wind Tunnel	Intermittent blowdown to vacuum	18 diameter, free jet	5,7,9,11	.11-6.78	640-3000	.17-4.95	3-122

B.4. HYPERSONIC WIND TUNNELS (University Owned)

Organization Location Facility Name	Type of Facility	Test Section Size (Dimensions in inches)	Mach Range	Reynolds Number Per Ft x 10 ⁻⁶	Total Temp. (°R)	Dynamic Press. (psf)	Page
UNIVERSITY OWNED							
University of Michigan Ann Arbor, Michigan Hotshot Wind Tunnel	Arc discharge	20 diameter	11-27	.0015-2	6000	Not Available	3-124

C.1 SUBSONIC TUNNELS

AFFDL VERTICAL WIND TUNNEL

REPORTING INSTALLATION: Air Force Flight Dynamics Laboratory (FDFR) Wright-Patterson AFB, Ohio 45433	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Air Force Flight Dynamics Laboratory Recovery and Crew Station Branch (FDFR)
OTHER SOURCES OF INFORMATION: AF Technical Facility Key, No. AFSCP 80-3, September 1967	LOCAL OFFICE TO CONTACT FOR INFORMATION Same as Reporting Installation Phone: (513) 255-4008

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a vertical, atmospheric, annular return, continuous flow type wind tunnel with a 12-foot free jet. The air is drawn up through the 12-foot long test section by a four bladed fan, 16 feet in diameter. This tunnel is powered by a variable rpm 1000 hp main drive.

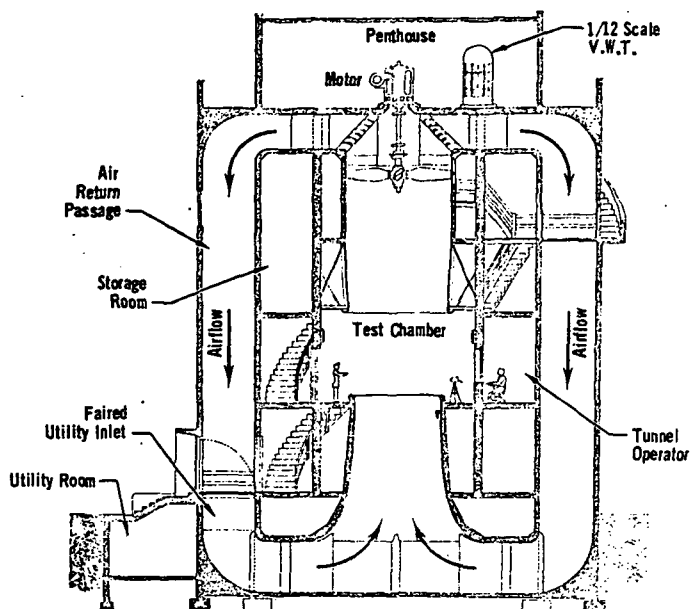
TESTING CAPABILITIES: This wind tunnel is used to determine the drag and stability characteristics of parachutes, rotary type decelerators, and primary vehicles with and without augmenting drag devices and to investigate the spin and recovery characteristics of flight vehicles. The tunnel is equipped with a gauss ring to magnetically actuate spin-recovery control surface deflections on the model. A sting balance capable of six-component measurements is available. The sting balance is affixed to a support structure downstream of the nozzle. The support structure can provide remote control of the sting in pitch, roll and yaw. Motion picture and still photographic coverage of tests are available. A twelve channel analog to digital data acquisition system is used to record model force and moment data, model positioning and airspeed in the test section. Data reduction is accomplished off site.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$320	CONSTRUCTION YEAR: 1944 COST \$ 720,000 ESTIMATED REPLACEMENT VALUE \$1,600,000
CONTRACTOR: Unknown	LOCATION:
IMPROVEMENTS AND COSTS: (1967) New velocity control system (1968) Five-component parachute balance	

PLANS FOR FACILITY IMPROVEMENTS: Wind tunnel adaptation for "finite mass" type parachute testing (controlled parachute movement in the test section).

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .14
Reynolds Number ($\times 10^6/\text{ft}$):	0 to .91
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 26
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

AFIT 5-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: Air Force Institute of Technology Building 640, Area B Wright-Patterson AFB, Ohio 45433	STATUS OF FACILITY: Active
	COGNIZANT ORGANIZATIONAL COMPONENT: Aerospace Design Center AFIT-SED Phone: (513) 255-4296
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Aerospace Design Center

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an open return, continuous flow, atmospheric induction tunnel of circular cross section and wooden construction. The test section is 5 feet in diameter and 18 feet long. The tunnel has a contraction ratio of 3.7/1 and a turbulence factor of 1.5. It has four D.C. drive motors driving two contra-rotating fans. One to four drive motors may be engaged to provide very low speed testing from 4 mph up to 250 mph with a model.

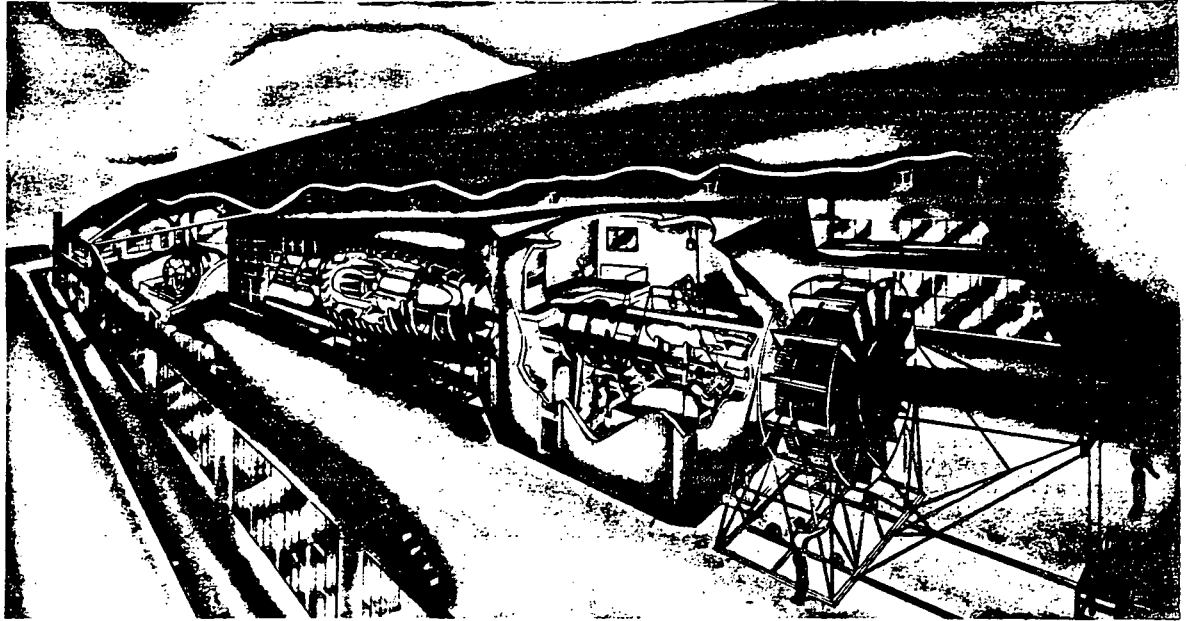
TESTING CAPABILITIES: The facility is capable of force, moment, pressure, and flutter testing. The tunnel normally uses a 3 element (L,D,M) wire balance which can be extended to 5 element (L,D,M,N,I) through use of strain gauge links in the lift and drag wires. Yaw and roll cannot be tested. A six element sting-yoke mounted strain gauge balance can be used with +15° in yaw and pitch. The test section can be modified by side boards to simulated 2D flow in a 30" x 60" x 15' channel. A variable height ground board is available. The wire balance has tape readout with manual reading. After manual reading and card punching, computer facilities are available for data reduction on 24 hour call.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	\$250 occupancy (See Note)	CONSTRUCTION YEAR: 1922 ESTIMATED REPLACEMENT VALUE	COST \$ 916,000 \$2,500,000
CONTRACTOR: Unknown		LOCATION:	
IMPROVEMENTS AND COSTS: (1969) Motor-generator set, drive motors, and controls were completely overhauled and rewired, tunnel structure completely overhauled.			
NOTE: This tunnel is a school tunnel and no cost data is available.			

PLANS FOR FACILITY IMPROVEMENTS: The wire balance is to be rewired to improve automatic control. Strain gauge links have been successful in obtaining digital voltmeter read-out which may be converted to tape or punch card read-out to enable on-line data reduction with the base central computer. This is contingent upon funding. A new sting mount for the strain gauge balance has been designed, and will be constructed as funds become available.

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .35
Reynolds Number ($\times 10^6/\text{ft}$):	.02 to 3
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	.5 to 100
Total Temperature ($^{\circ}\text{R}$):	555
Run Time:	Continuous

BOEING V/STOL WIND TUNNEL

REPORTING INSTALLATION: The Boeing Company Vertol Division P.O. Box 16858 Philadelphia, Pennsylvania 19142	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Wind Tunnel Organization (Org Number 7890)
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Manager, Boeing V/STOL Wind Tunnel Phone: (215) 522-3964

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is a closed circuit, single return, continuous flow V/STOL wind tunnel. This test section has fixed dimensions of 20 feet high by 20 feet wide and can be modified to permit testing in a 45 foot long closed or 15% porous slotted wall configuration or a 23 foot long open throat configuration. The tunnel has a contraction ratio of 6.1. The test section is equipped with a moving ground belt to simulate ground effects. Auxiliary air is available for boundary layer control simulation and an air exchange system is provided to enable live engine tests to be conducted. The tunnel is powered by a 15,000 hp variable rpm main drive, which propels a 39-foot diameter propeller.

TESTING CAPABILITIES: This facility is used in tests of helicopter configurations including tilt wing, tilt-rotor, stowed rotor and other aerodynamic tests. An endless moving belt ground plane, which provides flight realism for models requiring ground effects, can be used to replace the test section floor. The moving ground plane is raised and lowered into position by a special elevator located directly under the test area. Models are supported on strings or pedestal type mounts, and cable type supports are available. Various auxiliary model motor power supplies are available: 400 hp, 0-400 Hz, .5-2.0 V/Hz; 200 hp, 0-600 Hz, .5-1.0 V/Hz; 125 hp, 0-600 Hz, 0-2.0 V/Hz. An auxiliary air pressure supply is available providing 20 lb/sec and 1000 psia air. A 128 channel data recording system is provided and an on-site IBM 1800 computer, which computes on-line digital processing, full corrections, listing and necessary plots.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): (See Note Below)	CONSTRUCTION YEAR: 1968 COST \$ 8,551,144 ESTIMATED REPLACEMENT VALUE \$10,550,000
CONTRACTOR: Fleming Co., Preload Co., Nason-Cullen, Inc., LOCATION: Pittsburgh-Des Moines Steel Co.	
IMPROVEMENTS AND COSTS: (1969) Calibration data system, Cost \$10,500; (1969) Q-Reducer, Cost \$37,000; (1969) Test floor insert, Cost \$23,000; (1970) Safety items, Cost \$67,000.	
NOTE: The wind tunnel was designed and constructed to support Boeing internal and Government contract requirements which are not normally offered to the general public or industry. Accordingly, costs are not accountable on the basis of a typical eight hour shift.	

PLANS FOR FACILITY IMPROVEMENTS: None.

Note: All Dimensions in Feet



1~7

BOEING 9-FOOT BY 9-FOOT LOW SPEED WIND TUNNEL

REPORTING INSTALLATION: The Boeing Company Commercial Airplane Division P.O. Box 3707 Seattle, Washington 98124	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Propulsion-Mechanical Laboratory - CAG
OTHER SOURCES OF INFORMATION: Document Nos. D6-24400; D6-12156TN December 1969	LOCAL OFFICE TO CONTACT FOR INFORMATION: A. J. Daniels, Mech. Eng. Lab Phone: (206) 655-1970

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an open circuit induction tunnel powered by an Allison 501-D13 turboprop aircraft engine. The test section is 9 feet by 9 feet by 14.5 feet long and is removable for model installation. Five alternate test sections are available to facilitate model buildup. Auxiliary support equipment is available to provide test models with dry air up to 1000 psi, hot exhaust product gas up to 8 lb/sec at 1500°F, vacuum ranging from 48 lb/sec at 10.3 psia to 3.75 lb/sec at 2.95 psia, and steam at 135 psi.

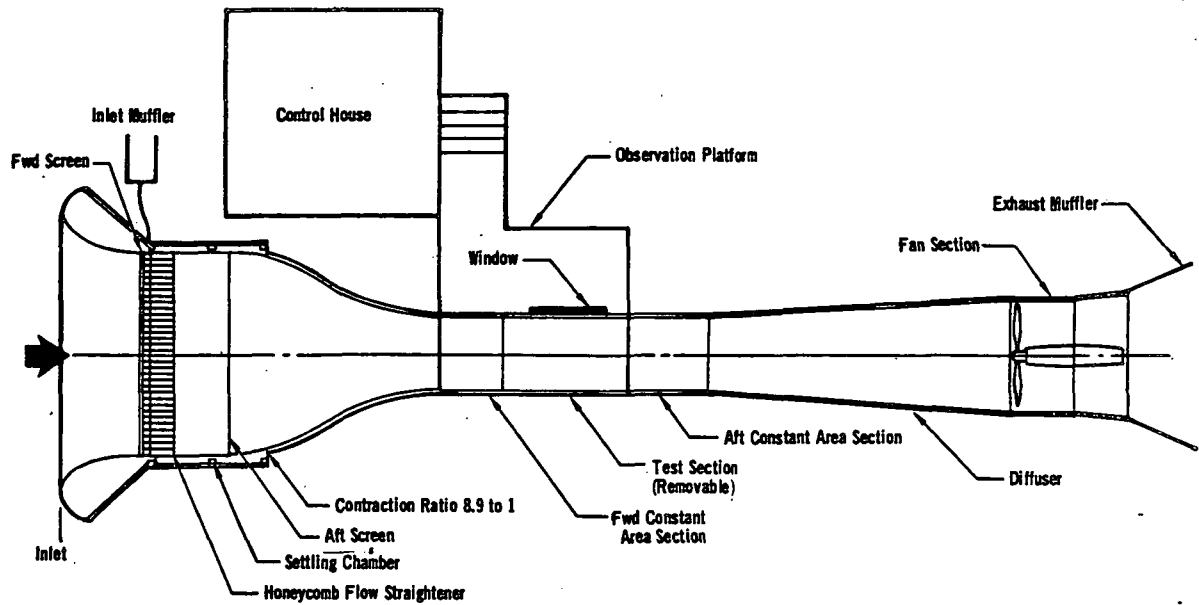
TESTING CAPABILITIES: The 9-foot by 9-foot tunnel provides low speed airflow for testing engine inlet and exhaust systems and propulsion aerodynamic systems. Models may be sting mounted or on a horizontal or vertical ground plane. The data system is capable of recording up to 400 channels on punch paper tape. Data reduction is accomplished with SDS 92 computer and quick look CDC 6600 computer for final data.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1967-69 COST \$510,000 ESTIMATED REPLACEMENT VALUE \$565,000
CONTRACTOR: The Boeing Company	LOCATION: Seattle, Washington
IMPROVEMENTS AND COSTS: (1967) Increased vacuum capacity, Cost \$71,000; (1967) Alternate test sections, Cost \$15,000; (1969) Data system and control house, Cost \$100,000.	

PLANS FOR FACILITY IMPROVEMENTS: Installation of sound suppression.

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .36
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 2.26
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 127
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

BOEING LOW SPEED RESEARCH TUNNEL

REPORTING INSTALLATION: The Boeing Company Commercial Airplane Division P.O. Box 3707 Seattle, Washington 98124	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Commercial Airplane Group
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. W. A. Blissell, Jr. Org C-8340, M.S. 1W-82 Phone: (206) 655-1823

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow, atmospheric tunnel. The test section is 8 feet high by 3 feet wide by 20 feet long in the present configuration. The design allows the test section width to be changed to any dimension up to 5 feet at moderate cost to meet special test requirements. Contraction ratio is 12/1 in the 3 ft x 8 ft configuration, 7.2/1 in the 5 ft x 8 ft configuration. The hot wire turbulence level is about .07%. Auxiliary air and suction systems are available. The tunnel is powered by a 600 hp, variable rpm main drive, which propels a 12-foot diameter fixed pitch propeller.

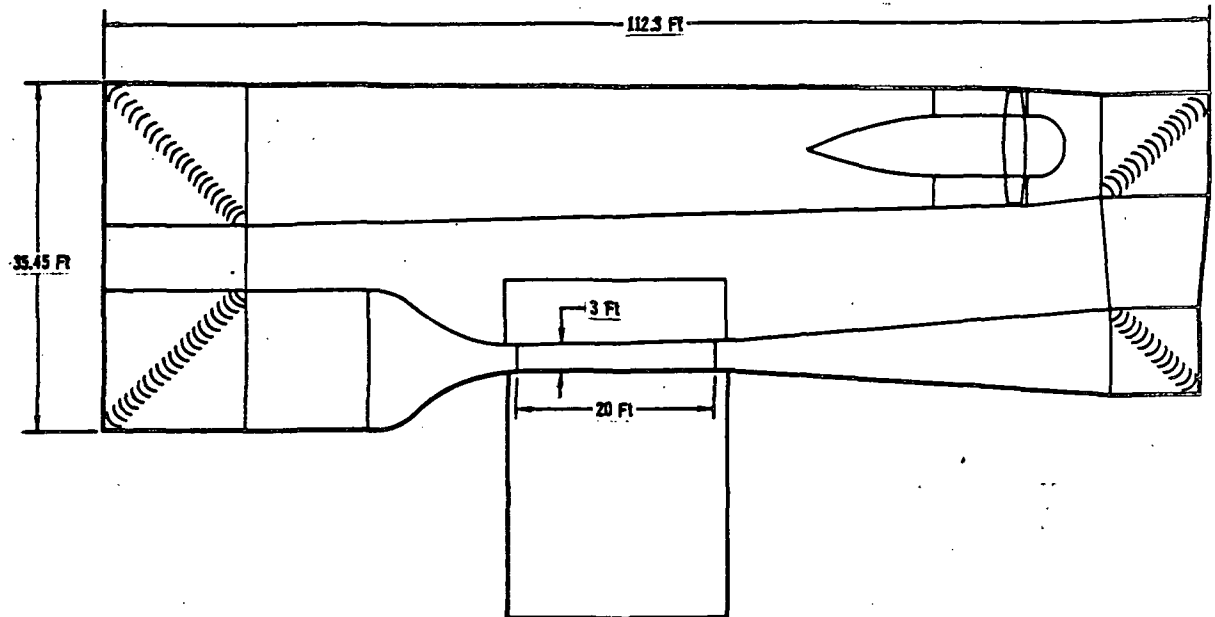
TESTING CAPABILITIES: This facility is currently used for two-dimensional testing, especially high lift configurations. Models mount to sidewall turntables and forces are determined with a six-component external balance and surface and wake pressure integrations. Provision is made for taking auxiliary air across the balance. Blowing and suction systems are available at the tunnel. Pressure data are recorded using scanivalves. An auxiliary air pressure supply, 20 lb/sec at 1000 psia; and a 1.5 lb/sec at 12 psid, a 9.5 lb/sec at 3 psid auxiliary evacuation systems are all available. Data are recorded through 12 channels with a Servo Potentiometer, Encoder and Punch Cards and reduced with an off site digital computer.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1968 COST \$446,000 ESTIMATED REPLACEMENT VALUE \$540,000
CONTRACTOR: Boeing in-house project IMPROVEMENTS AND COSTS:	LOCATION: Seattle, Washington

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	.025 to .3
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 2
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	1 to 140
Total Temperature ($^{\circ}\text{R}$):	480 to 600
Run Time:	Continuous

GALCIT 10-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: California Institute of Technology (GALCIT) 1201 East California Boulevard Pasadena, California 91109	STATUS OF FACILITY: <u>Active</u> COGNIZANT ORGANIZATIONAL COMPONENT: Aeronautics Department
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Guggenheim Aeronautical Laboratory GALCIT 10-Foot Wind Tunnel Phone: (213) 681-7171, ext 1795

DESCRIPTION AND TESTING CAPABILITIES

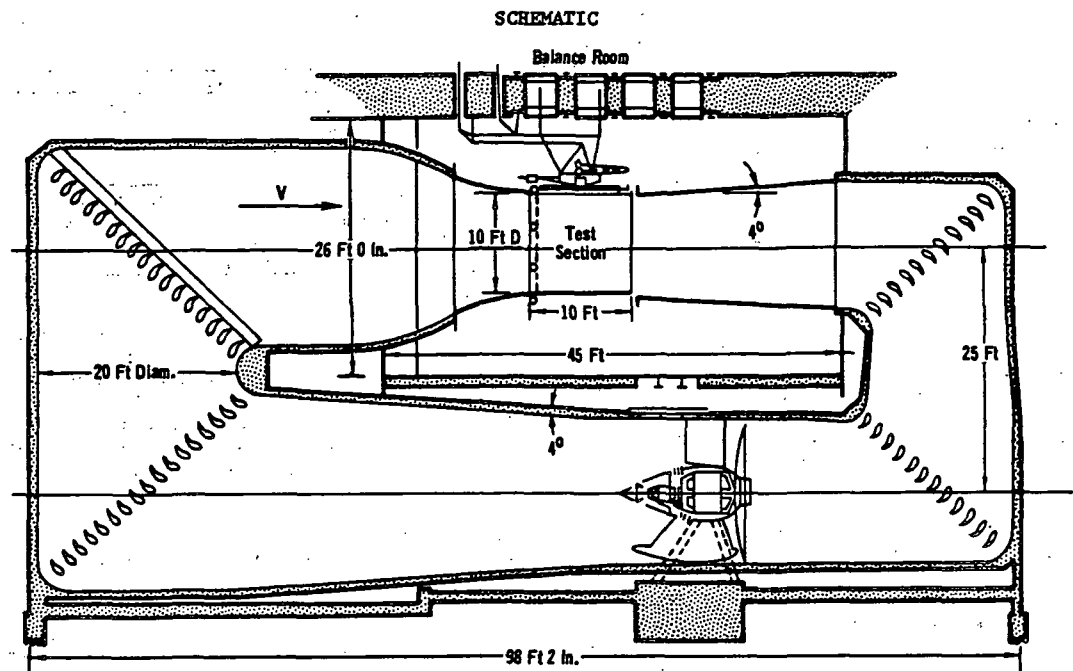
FACILITY DESCRIPTION: This is a closed, single return, continuous flow, atmospheric type tunnel. The circuit is of circular cross-section throughout incorporating a test section 10 feet in diameter and 10 feet long. The tunnel is normally operated without turbulence reducing screens with a resultant airstream root-mean-square turbulence of .0064. Provisions are incorporated to use five 30 x 30 mesh screens in the contraction section which reduces the root-mean-square turbulence to .0015. Airstream cooling and limited temperature control are provided by a 5% air exchange and chilled water flowing through the three-dimensional turning vanes of corners 1 and 2. The tunnel is powered by a 600 hp main drive propelling a 15 foot propeller.

TESTING CAPABILITIES: Testing typically accomplished in this facility include static force and moment, internal duct and external pressure surveys, flow visualization and dynamic force and amplitude. Special provisions are available to evaluate ship and powerplant stack gas problems and to test in a 20 foot diameter vertical airstream at air velocities up to 40 mph using the vertical leg upstream of the contraction section. Auxiliary equipment consists of: model motor power supply (50 hp, 30-330 cps, .5-2.3 V/cycle), high pressure air supply, (2 lb/sec), auxiliary evacuation system (2 lb/sec) and ground reflection planes. The basic model suspension and balance system consists of a truncated pyramid external balance with direct six-component readout from automatic balancing, moving poise, beam type balances and single, tandem or three strut windshieldd model support. Complete image systems are available to evaluate aerodynamic tares for this system. In addition, special sting support and ground plane support systems are available. Data reduction is accomplished by desk calculators on site and by IBM 360/75 on campus.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1200	CONSTRUCTION YEAR: 1929 COST \$ 250,000 ESTIMATED REPLACEMENT VALUE \$2,500,000
CONTRACTOR: Unknown	LOCATION:
IMPROVEMENTS AND COSTS: (1941) Present external balance system, Cost \$50,000; (1950-69) Miscellaneous data systems, Cost \$30,000; Others plus total through 1969, Cost \$330,000.	

PLANS FOR FACILITY IMPROVEMENTS: New Automatic Data Acquisition System for the external balance system has been designed and is expected to be placed into operation late during 1971.



FACILITY PERFORMANCE DATA

Mach Range:	.03 to .22
Reynolds Number ($\times 10^6/\text{ft}$):	.16 to 1.41
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	1 to 72
Total Temperature ($^{\circ}\text{R}$):	500 to 580
Run Time:	Continuous

GENERAL DYNAMICS 8-FOOT BY 12-FOOT SUBSONIC WIND TUNNEL
(With Tandem V/STOL)

REPORTING INSTALLATION: General Dynamics Corporation Convair Division P.O. Box 1950 San Diego, California 92112	STATUS OF FACILITY: Active
	COGNIZANT ORGANIZATIONAL COMPONENT: General Dynamics, Convair Division Dept 508-0 San Diego, California
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. W. T. MacCarthy or Mr. J. H. Struthers General Dynamics Aeromarine Test Facilities Phone: (714) 296-6611, ext 1184 or 1286

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a subsonic, atmospheric, closed circuit, single return, continuous flow type tunnel. The prime test section is 8 feet by 12 feet by 15 feet. In 1961, a 16 by 20 by 24 foot section was installed downstream of the 8-foot by 12-foot section. This added section is used primarily for V/STOL testing. Three screens are installed downstream of the 8-foot by 12-foot section to smooth the airflow in the new 16-foot addition for V/STOL tests. The tunnel is powered by a 2250 hp main drive, which propels a 20-foot diameter propeller. The tunnel has a contraction ratio of 6.55 to 1. A steam driven (5 lb/sec at 12.5 psia, lesser flow at 7.5 to 12.5 psia) auxiliary evacuation system is used at this facility.

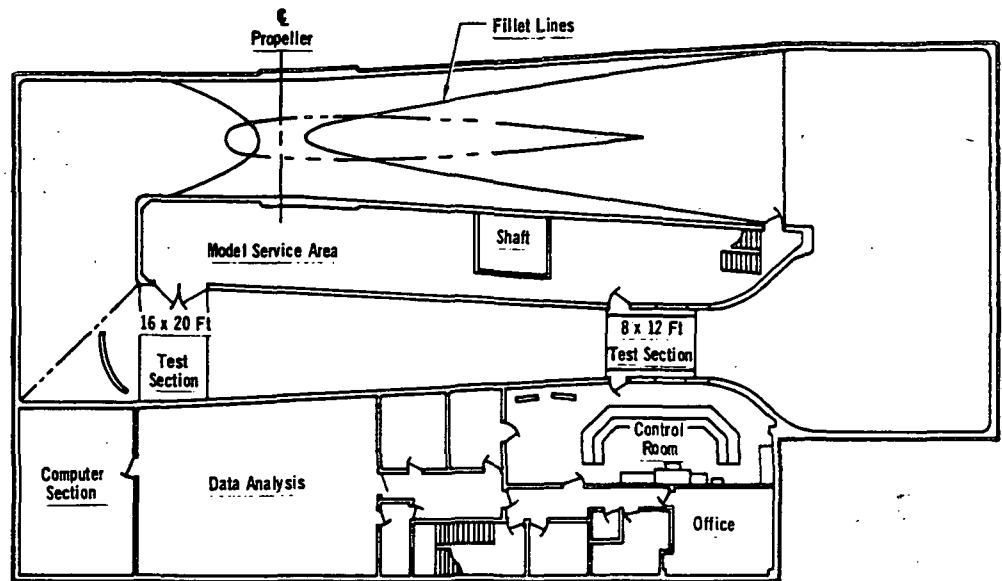
TESTING CAPABILITIES: This tunnel is capable of conventional type aerodynamic tests. A wide variety of mounting systems is available: single, dual and triple struts, reflection plane and a sting support, which is used in the 16-foot V/STOL section. A moving belt ground board system is available for tests in the 8 by 12-foot section obtaining accurate simulation of ground effect conditions at speeds up to 120 feet per second. Auxiliary equipment includes 22 lb/sec maximum, 500 psig air supply, 1/2 atmosphere suction system, a 100 kW, 0-500 Hz variable model motor supply and a 75 kW, 0-300 Hz variable model motor supply. Data is recorded using a 50 channel DVM/Programmer System and reduced on an on site IBM 1130 Electronic Digital Computer.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$110/hour (See Note)	CONSTRUCTION YEAR: 1946 COST \$ 650,000 ESTIMATED REPLACEMENT VALUE \$2,500,000
CONTRACTOR: The Austin Company	LOCATION: Los Angeles, California
IMPROVEMENTS AND COSTS: (1961) 16' x 20' test section, Cost \$30,000; (1965) Auxiliary air supply 500 psig, Cost \$170,000; (1965) Velocity reduction system for dynamic tests, Cost \$10,000; (1967) Two-dimensional test section, with BLC, Cost \$22,000; (1969) Moving belt ground simulation, Cost \$55,000; (1970) Addition of honeycomb, Cost \$59,000.	
NOTE: Labor costs are in addition and can be provided only on a specific estimate for a specific test. Pipeline occupancy charge is \$40 per hour, if required.	

PLANS FOR FACILITY IMPROVEMENTS: Increase the velocity capability of the moving belt from 120 to 200 ft/sec. Possible addition of on-line computing capability. The facility has in the past and will in the future be available to any customer.

SCHEMATIC



FACILITY PERFORMANCE DATA

Low Speed Section

Mach Range: .04 to .37

Reynolds Number ($\times 10^6/\text{ft}$): .25 to 2.5

Total Pressure (psia): Atmospheric

Dynamic Pressure (psf): 2 to 200

Total Temperature ($^{\circ}\text{R}$): Ambient

Run Time: Continuous

V/STOL Section

Mach Range: .02 to .08

Reynolds Number ($\times 10^6/\text{ft}$): .1 to .55

Total Pressure (psia): Atmospheric

Dynamic Pressure (psf): .5 to 10

Total Temperature ($^{\circ}\text{R}$): Ambient

Run Time: Continuous

GEORGIA INSTITUTE OF TECHNOLOGY 9-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: Georgia Institute of Technology Aerospace Department Atlanta, Georgia 30332	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: School of Aerospace Engineering
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Professor John J. Harper Phone: (404) 873-4211, ext 405

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a single return, closed circuit, continuous flow, atmospheric tunnel. If the need is for a two-dimensional tunnel, a plywood insert transforms the 9-foot diameter section into a near rectangle, 9 feet by 2-1/2 feet. For open-throat testing, the entire test section may be removed. The tunnel is powered by a 600 hp main drive and has a turbulence factor of 1.2. An auxiliary air supply is available.

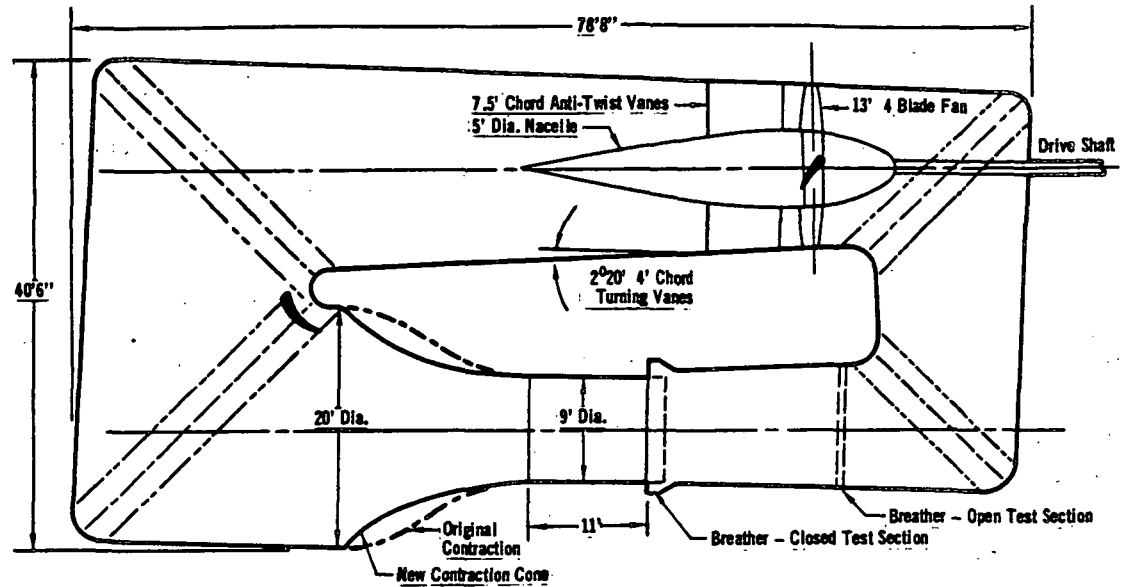
TESTING CAPABILITIES: This tunnel does the usual aerodynamic studies, which are obtained by a yoke type balance system. Single, double, and triple strut mounts are available. Data reduction is done at the Rich Electronic Computer Center, which is on campus.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$640	CONSTRUCTION YEAR: 1931 COST \$ 18,000 ESTIMATED REPLACEMENT VALUE \$1,000,000
CONTRACTOR: Rust Engineering	LOCATION: Birmingham, Alabama
IMPROVEMENTS AND COSTS: (1945) New balance system, Cost \$45,000; (1955) New weigh beams, 8 channel printer, Cost \$21,000; (1954-56) New test section, contraction cone, fan and drive, Cost \$62,000; (1964) Converted balance to yoke type, new data readout, Cost \$6,000.	

PLANS FOR FACILITY IMPROVEMENTS: Convert present 9-foot diameter test section to 7 x 9; New two dimensional insert.

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .27
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 1.6
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 57
Total Temperature ($^{\circ}\text{R}$):	590
Run Time:	Continuous

GRUMMAN 7-FOOT BY 10-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: Grumman Aerospace Corporation Plant Number 5 Bethpage, L.I., New York 11714	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Test Section, Department 400
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Aero Test Section, Department 400, Bethpage, L.I., New York Phone: (516) 575-7044

DESCRIPTION AND TESTING CAPABILITIES

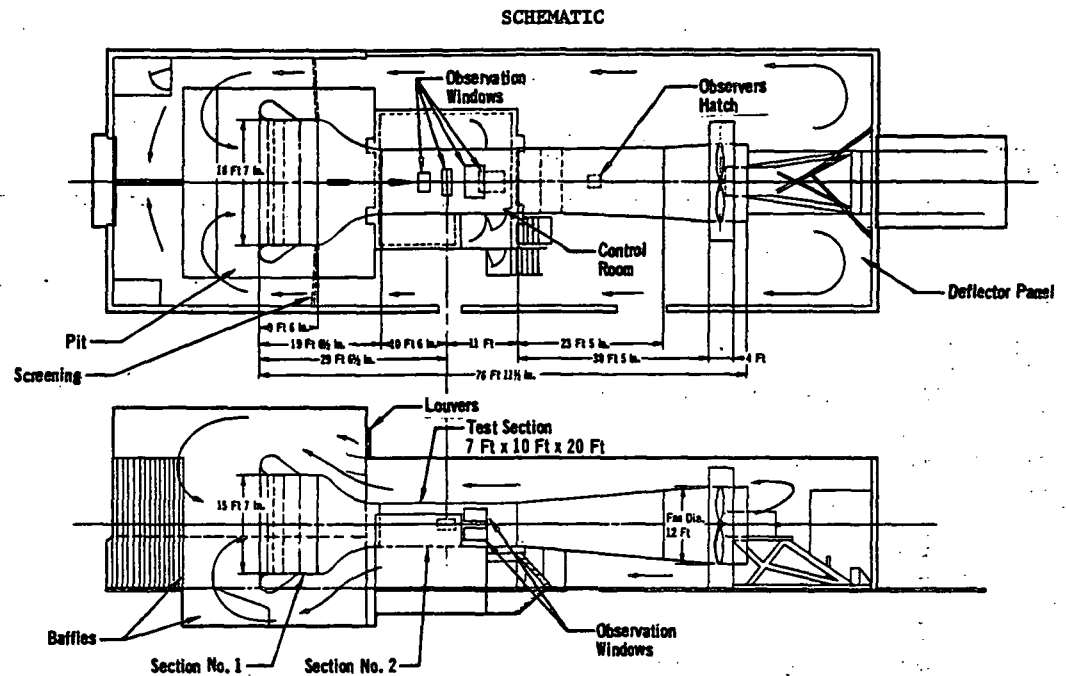
FACILITY DESCRIPTION: This is a continuous flow, open return, closed throat, atmospheric type wind tunnel. The test section is 7 by 10 by 20 feet. A 12 foot diameter propeller is driven at speeds up to 1200 rpm by a 1750 horsepower induction electric motor. The tunnel has a contraction ratio of 4.25 to 1.

TESTING CAPABILITIES: This facility is equipped for aerodynamic force and pressure testing on three-dimensional, two-dimensional, and reflection plane models. Capability also exists for conducting powered model, flutter, jet flap, flow visualization, and wake survey tests. Available model supports include: two and three point supports, a single mount with fixed linkages for setting model pitch attitude, wire supports, and a pedestal mount for half model tests. Special installations can be provided to sting support models. Image systems are available for evaluating model support tare and interference effects. Removable wall inserts are available for two-dimensional tests and a stationary ground plane is available for investigating ground effects. The tunnel primary balance is a six-component mechanical external yoke type. The balance incorporates a pitch arm with $\pm 45^\circ$ pitch capability and a yaw table which can provide $\pm 45^\circ$ of yaw. Capability also exists for conducting tests with internal strain gage balance installations. A variable frequency power unit having a range from 0 to 660 Hz, and a maximum output of 100 kW is available for the three-phase induction motors used in powered models. An auxiliary air supply (2.3 lb/sec, 70 psi) is available. An IBM 1800 computer system serves as the facilities data acquisition and reduction center. It is dedicated to the facility and provides on-line data reduction capability. On-site plotting is also available on a Calcomp drum-type plotter. The facility can provide photographic, closed-circuit and play-back television documentation. Manometers and scanivalves are available for pressure recording.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1000	CONSTRUCTION YEAR: 1948 COST \$ 160,000 ESTIMATED REPLACEMENT VALUE \$1,500,000
CONTRACTOR: Tallar/Cooper, & Grumman Aerospace Corp. LOCATION: New York, N.Y. & Bethpage, N.Y. IMPROVEMENTS AND COSTS: (1954) Auxiliary air supply, electric main drive, automated data acquisition, Cost \$170,000; (1959) Auxiliary model motor power supply and motors, Cost \$100,000; (1954-65) Enlarged building, Cost \$70,000; (1960) Suction equipment, Cost \$20,000; (1965-67) Scanivalve and IBM 1700 acquisition system, Cost \$20,000 rental; (1967) IBM 1800 system and instrumentation, Cost \$50,000 rental.	

PLANS FOR FACILITY IMPROVEMENTS: (a) New sting mount system, (b) Additional strain gage balances, (c) Increased yaw rate, (d) Modernization and expansion of building.



FACILITY PERFORMANCE DATA

Mach Range:	0 to .18
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 1.7
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 46
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

LTV VAD 7-FOOT BY 10-FOOT AND 15-FOOT BY 20-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: LTV Aerospace Corporation P.O. Box 5907 Dallas, Texas 75222	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Vought Aeronautics Division
OTHER SOURCES OF INFORMATION: Facility Handbook, Publication AER-EOR-12995-B	LOCAL OFFICE TO CONTACT FOR INFORMATION: Gas Dynamics Laboratories Phone: (214) 266-3234, ext 2130

DESCRIPTION AND TESTING CAPABILITIES

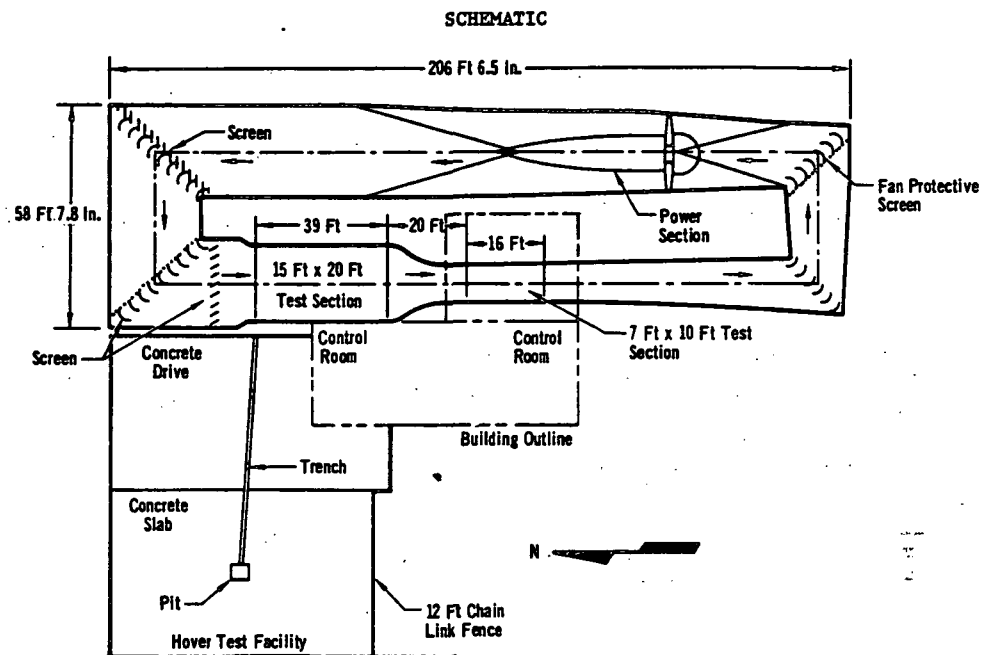
FACILITY DESCRIPTION: This is a horizontal single-return tandem test section closed circuit facility. The rectangular 7 x 10 foot test section is 16 feet long. The rectangular 15 x 20 foot section is 39 feet long and is located upstream of the 7 x 10 foot section in a tandem arrangement. The 7 x 10 foot section incorporates an external balance while internal strain gage balances are used in the 15 x 20 foot section. Three types of auxiliary model power are available: high pressure air (20 lb/sec at 500 psi); hydraulic (90 gpm at 5000 psi); variable frequency electric (two units each supplying 50 kW at 10 to 600 cycles per second). A moving ground belt system is located in the 15 x 20 foot section. The belt is 12 feet wide and 9-1/2 feet long. Models are supported in the 15 x 20 foot test section by a sting support system with provisions for variable model height above the ground belt. An electronic data recording system is available. Addition of an on-line computer is anticipated during 1970. Another capability reaching operational status in 1970 is a six degree of freedom, servo operated and computer controlled support system for store separation testing. A two-dimensional airfoil insert is also currently under development (1970). The tunnel has a 1500 hp main drive, which propels a 20-foot diameter propeller. The tunnel is owned by the U.S. Navy and operated by the Vought Aeronautics Division of the LTV Aerospace Corporation.

TESTING CAPABILITIES: This facility is capable of force and pressure measurements, flutter, store drop and captive trajectory separation, internal balance measurements, powered models, jet simulation, dynamic stability, ground effects, automotive, wind loads on buildings and other type structures. Model mounting consists of single, dual, triple strut; sting; flight path simulator system. Data are recorded on an IBM 523 Printer (50 channels) and reduced on an off site computer utilizing an on site remote control station.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1200 to \$1400	CONSTRUCTION YEAR: 1954 COST \$1,000,000 ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: Sverdrup and Parcel	LOCATION: St. Louis, Mo.
IMPROVEMENTS AND COSTS: (1966) Addition of V/STOL test section, model power systems, Cost \$500,000.	

PLANS FOR FACILITY IMPROVEMENTS: (1) Acquisition of an on-site computer to provide on-line data computations and plotting. This capability tentatively planned for 1970, (2) Design underway for capabilities of 2-dimensional testing to be operational late 1970.



FACILITY PERFORMANCE DATA

Low Speed Section		V/STOL Section	
Mach Range:	.30 to .36	Mach Range:	.0063 to .069
Reynolds Number ($\times 10^6$):	.26 to 2.17	Reynolds Number ($\times 10^6/\text{ft}$):	.058 to .49
Total Pressure (psia):	Atmospheric	Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	2 to 135	Dynamic Pressure (psf):	.5 to 7
Total Temperature ($^{\circ}\text{R}$):	Ambient $+20^{\circ}\text{F}$	Total Temperature ($^{\circ}\text{R}$):	Ambient $+20^{\circ}\text{F}$
Run Time:	Continuous	Run Time:	Continuous

LOCKHEED-CALIFORNIA 8-FOOT BY 12-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: Lockheed-California Company P. O. Box 551 Burbank, California 91503	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Fluid Dynamics Laboratory Rye Canyon, California
OTHER SOURCES OF INFORMATION None	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (213) 847-6121 Ext. 131-221

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a subsonic wind tunnel with a closed throat and single return. The test section is 8 X 12 feet and is 15 feet long. The test section is vented to atmospheric pressure resulting in a Reynolds number of 1.5×10^6 per foot at a typical test velocity of 175 mph and a dynamic pressure of 80 pounds per square foot.

TESTING CAPABILITIES: Three model supports are available. A fork and pitch arm is connected through the floor to an electromagnetic balance, so that six-component data may be taken in combined pitch and yaw. This balance system can also be used for semi-span tests using the floor as a reflection plane. There is also a through strut with a rotating pod for a sting support using internal balances. The pitch angle of the sting support is ± 25 degrees. A total capacity of 100 low level digital channels is available. Data are reduced on an IBM 1130 computer at the site.

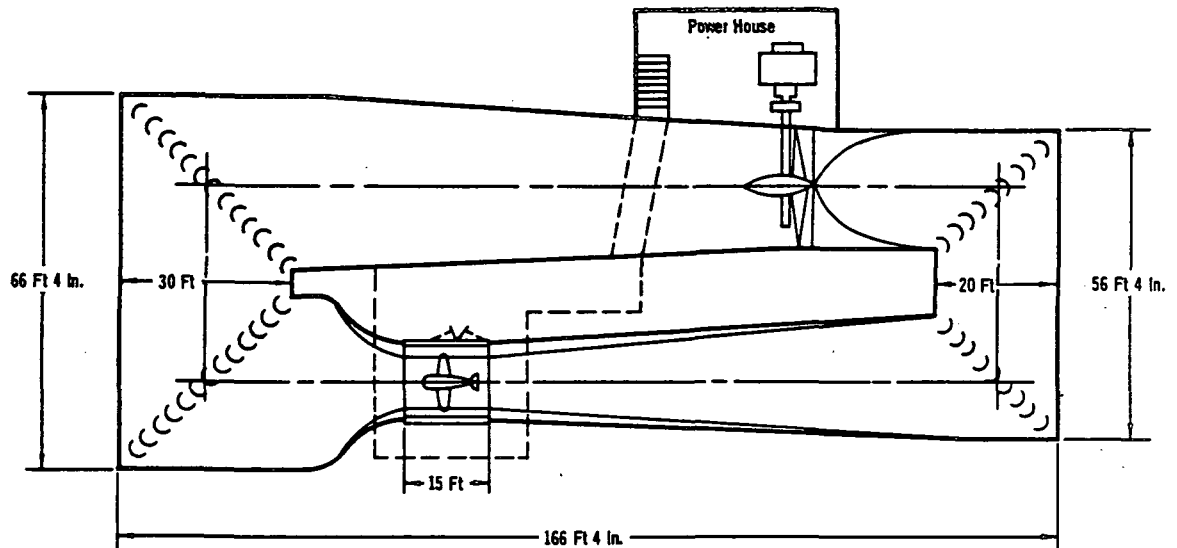
Auxiliary equipment includes a variable frequency power supply for powered tests, a vacuum pump with a flow rate of 3 pounds per second at -11 inches of Hg and an auxiliary air supply of 4 to 5 pounds per second at 100 psi absolute.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ Not Available ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .25
Reynolds Number ($\times 10^6/\text{ft}$):	0-1.5
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	.0 to 120.0 psf
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time (seconds):	Continuous

LOCKHEED-GEORGIA LOW SPEED WIND TUNNEL

REPORTING INSTALLATION: Lockheed-Georgia Company Department 7207, Zone 455 Marietta, Georgia 30060	STATUS OF FACILITY: Active
	COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Fluid Dynamics Department
OTHER SOURCES OF INFORMATION: Users Manual	LOCAL OFFICE TO CONTACT FOR INFORMATION: C. V. Williams, Zone 455 Phone: (404) 424-4158 B. W. Maddox, Zone 405 Phone: (404) 424-7406

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This wind tunnel is a closed circuit, single return, atmospheric facility having two test sections located in tandem. The upstream V/STOL test section is 26 feet wide, 30 feet high and 63 feet long. The downstream low speed test section is 16.25 feet high, 23.25 feet wide and 43 feet long. The contraction ratio of the V/STOL test section is 3.5. The contraction ratio of the low speed test section is 7. Vents are located at the downstream end of each test section to set stream static pressure at ambient conditions. Cooling of the facility is accomplished by spraying water over the external shell of the circuit. The wind tunnel is powered (9000 hp) by a 39 foot diameter fixed-pitch 6 bladed wood fan. Fan rotational speed can be varied from 12 to 330 rpm.

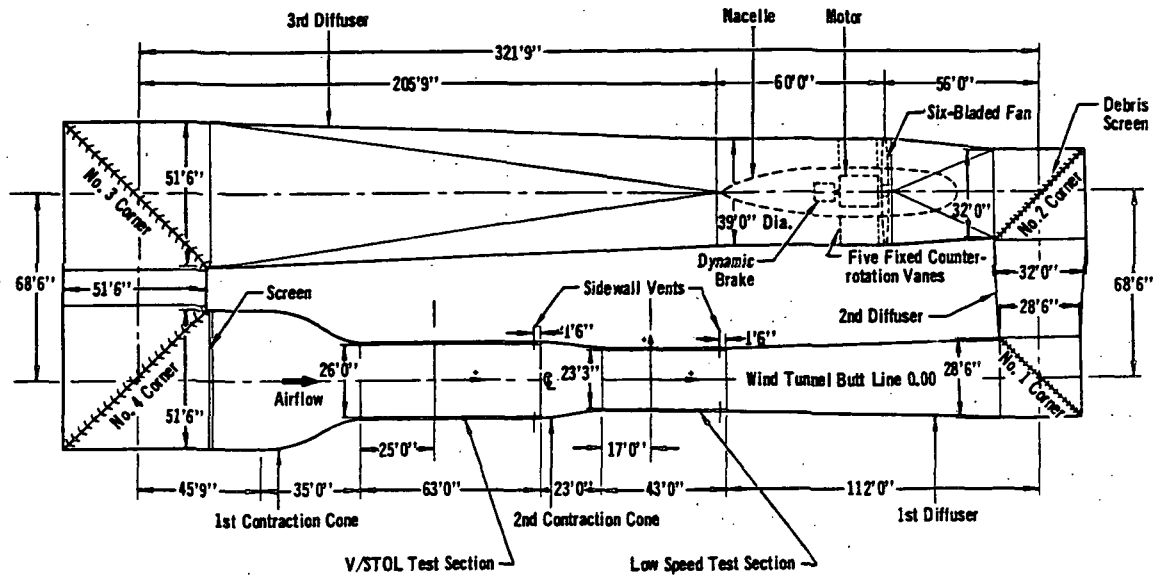
TESTING CAPABILITIES: This facility is capable of normal aerodynamic low speed (V/STOL) tests. Model mounting consists of: single-dual-triple struts and semispan type supports. The facility has compressed air (20 lb/sec at 350 psig) and variable frequency electric auxiliary systems to power simulated propulsion units in models. An external 6-component pyramidal balance is located under each test section. Balance, strain gage, pressure transducer, and rpm data are sampled using a CDC 1700 computer. Real-time programs (on site) provide data reduction to coefficient form with output in tabular and plotted form.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	\$5200 V/STOL Section \$2800 Low Speed Sec.	CONSTRUCTION YEAR: 1967	COST \$
CONTRACTOR: Sverdrup and Parcel	IMPROVEMENTS AND COSTS:	ESTIMATED REPLACEMENT VALUE \$	LOCATION: St. Louis, Missouri

PLANS FOR FACILITY IMPROVEMENTS: Moving Belt Ground Plane.

SCHEMATIC



FACILITY PERFORMANCE DATA

Low Speed Section	
Mach Range:	.04 to .32
Reynolds Number ($\times 10^6/\text{ft}$):	.3 to 2.0
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	2.0 to 160
Total Temperature ($^{\circ}\text{R}$):	570 (max)
Run Time:	Continuous

V/STOL Section	
Mach Range:	.02 to .16
Reynolds Number ($\times 10^6/\text{ft}$):	.15 to 1
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	.5 to 40
Total Temperature ($^{\circ}\text{R}$):	570 (max)
Run Time:	Continuous

MCDONNELL DOUGLAS LOW SPEED WIND TUNNEL

REPORTING INSTALLATION: McDonnell Douglas Corporation McDonnell Aircraft Company P.O. Box 516 St. Louis, Missouri 63166	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: General Engineering Division Gas Dynamics Laboratory (Dept 254)
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Gas Dynamics Laboratory McDonnell Aircraft, St. Louis Phone: (314) 232-4816

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow, atmospheric wind tunnel. The test section is 8.5 feet by 12 feet by 18 feet. An auxiliary air supply (20 lb/sec at 300 psig) is available. The tunnel has a contraction ratio of 7.35/1 and a turbulence factor of 1.16. The tunnel circuit is cooled by externally sprayed water. A 1750 hp main drive with variable rpm provides the tunnel power. This facility includes a propulsion test cell (20 ft x 30 ft x 15 ft) for testing powered models under zero airspeed conditions.

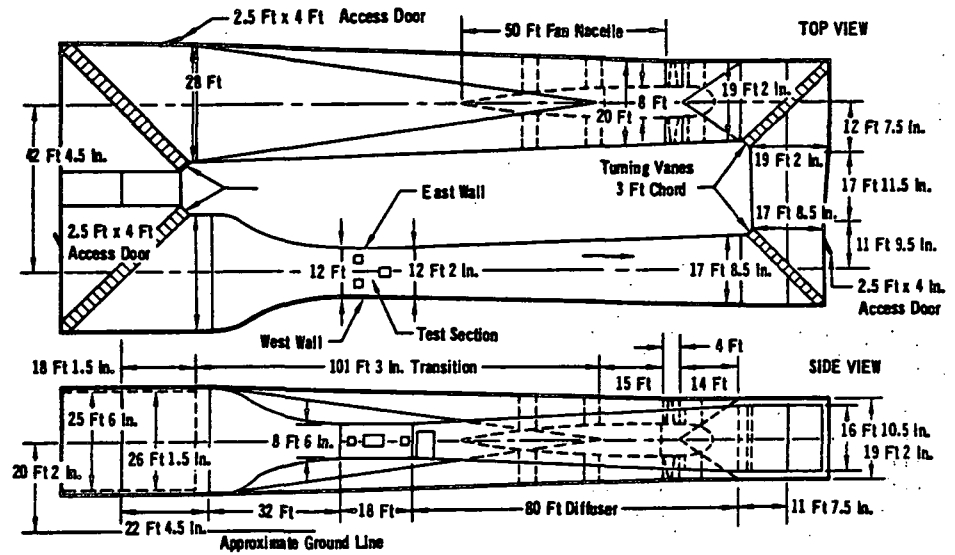
TESTING CAPABILITIES: This facility is capable of force and moment, pressure, flutter, inlet, two dimensional, and dynamic separation testing. The tunnel is equipped with an external pyramidal balance and internal strain gage balances. Model mounting consists of single-dual-triple struts, sting and other special types of supports. A water spray system has been used for rain simulation testing. A pneumatic (using auxiliary air supply) auxiliary model power supply is available (6-70 hp; 3-200 hp). An auxiliary evacuation system (18 lb/sec at 1/2 atmospheres) for drawing air from the tunnel circuit is being used. Data is recorded with a Datex 9 channel and C.S.C. 20 channel recorders and reduced on a S.E.L. 810A Digital Computer, which is on site. This facility is capable of three shift operation.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING \$1360 COST (TYPICAL 8 HOUR SHIFT): Government \$960	CONSTRUCTION YEAR: 1954 COST \$ 962,000 ESTIMATED REPLACEMENT VALUE \$3,000,000
CONTRACTOR: Sverdrup & Parcel; Pittsburgh-Des Moines LOCATION: St. Louis; Pittsburgh, Pa. IMPROVEMENTS AND COSTS: (1964) C.E.C. Data System (20 channel strain gage), Cost \$61,043; (1966) 600 psia auxiliary air line, zero airspeed facility, Cost \$144,810; (1967) Datex Data System (9 channel), Cost \$64,630; (1968) S.E.L. 810A Digital Computer, Cost \$150,000; (1969) Two dimensional Test Channel, Cost \$130,000.	

PLANS FOR FACILITY IMPROVEMENTS: Expansion of Zero Airspeed Facility.

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .30
Reynolds Number ($\times 10^6/\text{ft}$):	.2 to 2
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	10 to 125
Total Temperature ($^{\circ}\text{R}$):	570
Run Time:	Continuous

NASA AMES 40-FOOT BY 80-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-221-2 Moffett Field, California 94035	STATUS OF FACILITY: Active
	COGNIZANT ORGANIZATIONAL COMPONENT: Full-Scale and Systems Research Division Large-Scale Aerodynamics Branch
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Large-Scale Aerodynamics, Building N-221 Phone: (415) 961-1111, ext 2244

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a large, subsonic, closed circuit, single return, atmospheric wind tunnel. The test section is 40 by 80 feet. The tunnel has a contraction ratio of 8 to 1. The air is driven by six 40-foot-diameter fans each powered by a 6000-horsepower electric motor. The speed of the airflow through the test section is continuously variable from zero to the maximum.

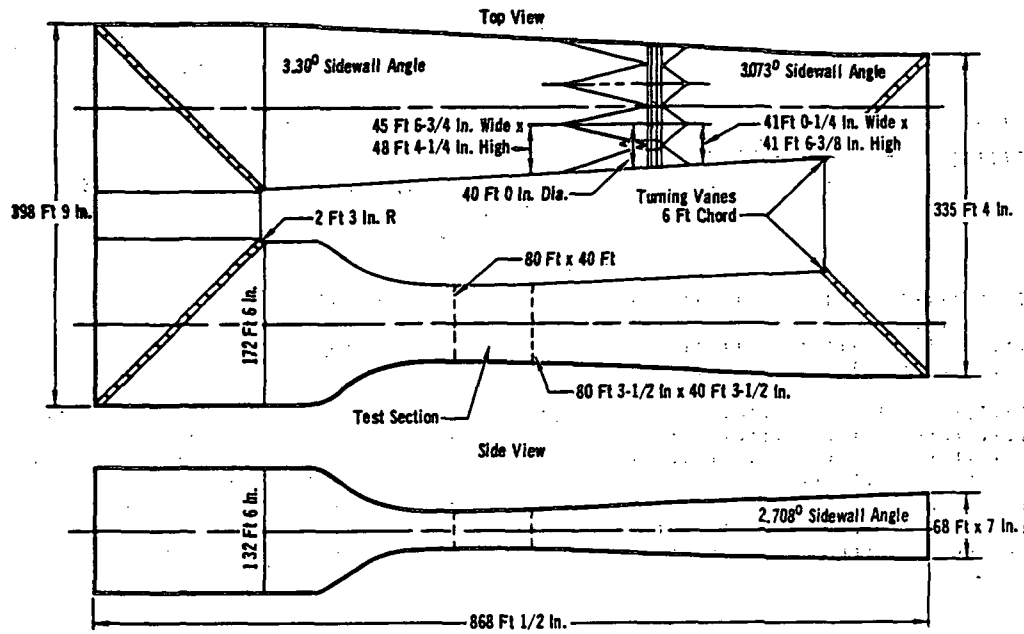
TESTING CAPABILITIES: This tunnel is used primarily for testing the low speed characteristics of high-performance aircraft and spacecraft, and for testing V/STOL aircraft and rotorcraft. Power for operation of model propellers, etc., can be obtained either from aircraft engines or electric motors (0-150 cycles, 2120 kVA; 0-400 cps, 706 kVA). Tests on turbojet engines with up to 15,000 pounds thrust can be made. A conventional support-strut system and a set of variable-height struts are available for studying the effects of ground proximity. Data are recorded on: Tunnel scale system (digital) 10 channels, Auxiliary data (digital) 480 channels, Analog tape 14 channels and reduced on site with cards read into computer.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1944 COST \$ 7,139,000 ESTIMATED REPLACEMENT VALUE \$28,077,000
CONTRACTOR: Pittsburgh Des Moines Steel Co. LOCATION: Santa Clara, California	
IMPROVEMENTS AND COSTS: (1944-49) Covering, louvers, 3rd floor constn, motor mods., Cost \$713,000; (1950-55) Motors, 5-ton crane, survey app., engine contr. rm., warehouse, Cost \$524,000; (1956-59) Alter shop annex, drive system cooling, elect. mod., Cost \$168,000; (1960-65) Mod. data building, strut syst. mod., Cost \$342,000; (1966-69) Exhaust, scale system, air conditioning, etc., Cost \$483,000.	

PLANS FOR FACILITY IMPROVEMENTS: Acquisition of an on-line computer and plotter.

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .3
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 2.1
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 138
Total Temperature (°R):	Ambient to 600
Run Time:	Continuous

NASA AMES 7-FOOT BY 10-FOOT SUBSONIC WIND TUNNEL NO. 1

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop 221-2 Moffett Field, California 94035	STATUS OF FACILITY: Standby COGNIZANT ORGANIZATIONAL COMPONENT: Full-Scale and Systems Research Division Large-Scale Aerodynamics Branch
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Large-Scale Aerodynamics Branch Phone: (415) 961-1111, ext 2244

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is a closed circuit, single return, atmospheric facility powered by a variable speed, 1800 hp motor which drives a fixed pitch fan. The tunnel has a rectangular test section 7 feet high, 10 feet wide and 15 feet long and a contraction ratio of 14.14 to 1.

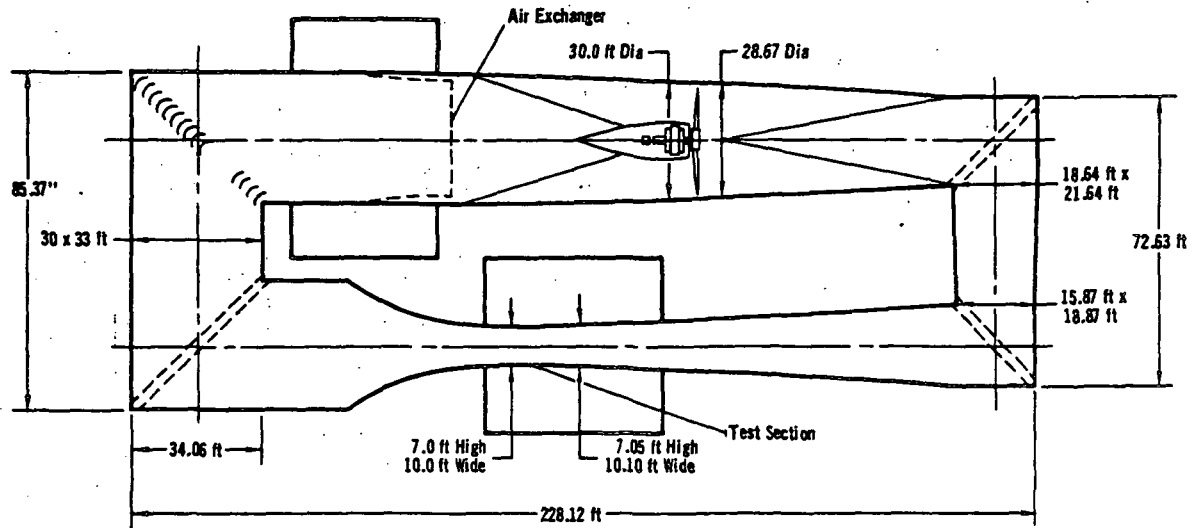
TESTING CAPABILITIES: This tunnel is capable of most aerodynamic type tests, 2-D airfoils, jet flap models and V/STOL models with scaled propulsion units. This tunnel can accommodate two-dimensional models spanning the tunnel height with supports at both floor and ceiling and three-dimensional models which can be supported by one vertical strut. Various electric model motors and variable frequency power to drive them are available (variable frequency, 0-400 Hertz, 100 kVA). Continuous angle of attack variation from 0° to $\pm 180^\circ$ is available. Data are recorded on tapes, mechanically printed (6 channels), and the cards are then read into a computer at the computing center.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1941 COST \$ 426,000 ESTIMATED REPLACEMENT VALUE \$2,358,000
CONTRACTOR: Moore Dry Dock Co. IMPROVEMENTS AND COSTS: (1941-48) Motor generators, strain gauge equipment, etc., Cost \$129,000; (1949-55) Revision to printers, Cost \$24,000; (1956-60) Computer station, Cost \$50,000; (1961-65) Modification to offices, Cost \$82,000.	LOCATION: Oakland, California

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .33
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 2.3
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 210
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

NASA AMES 7-FOOT BY 10-FOOT SUBSONIC WIND TUNNEL NO. 2

REPORTING INSTALLATION: U.S. Army Aeronautical Research Laboratory NASA Ames Research Center Moffett Field, California 94035	STATUS OF FACILITY: Active (Army operated) COGNIZANT ORGANIZATIONAL COMPONENT: (Same as Reporting Installation)
OTHER SOURCES OF INFORMATION: a) National Wind Tunnel Summary, NASA and DOD, 1961 b) Research Facil. Summary, Vol II, NASA Ames Dec '65 c) Tech. Facilities Capability Catalog, Ames Jul '66	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation), Building 216 Phone: (415) 961-1111, ext 2325

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel was essentially identical to the Ames 7-foot by 10-foot Subsonic Wind Tunnel No. 1 at the time of their construction. It is a closed circuit, single return, atmospheric facility powered by a variable speed, 1800 hp motor which drives a fixed pitch fan. The tunnel has a rectangular test section 7 feet high, 10 feet wide and 15 feet long and a contraction ratio of 14.14 to 1. Since initiation of a use permit from NASA to the Army in 1965, the No. 2 tunnel has been extensively refurbished and modernized.

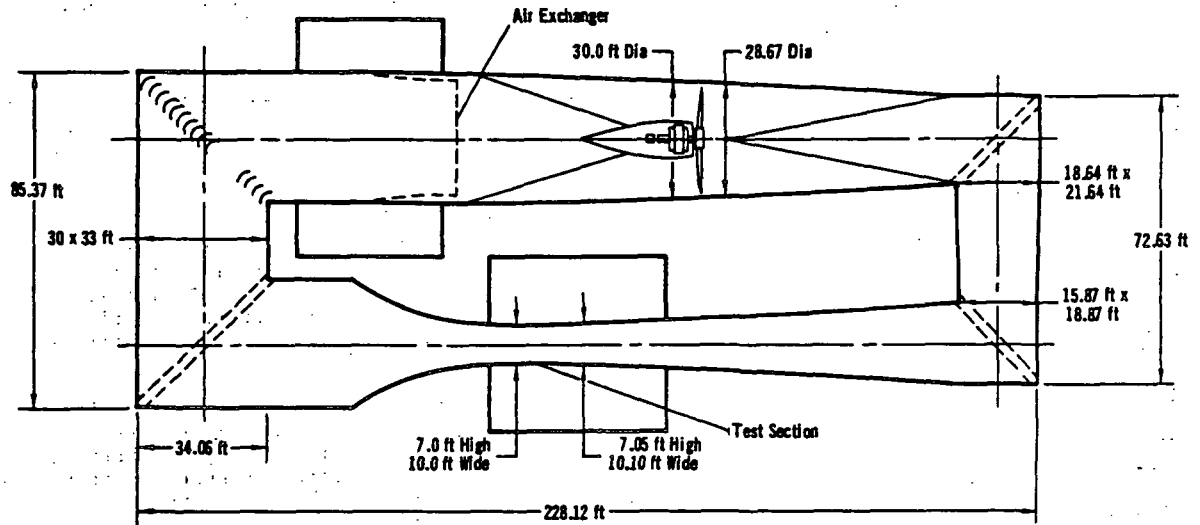
TESTING CAPABILITIES: This tunnel is capable of most aerodynamic type tests including tests of 2-D airfoils, jet flap models and V/STOL models with scaled propulsion units. It can accommodate two-dimensional models spanning the tunnel height with supports at both floor and ceiling and three-dimensional models which can be supported by one, two or three vertical struts. Various electric model motors and variable frequency power to drive them are available (150 hp, 0-400 Hz, .4 to 1.5 volts/cycle). Continuous angle of attack variation from 0 to $\pm 180^\circ$ is available. The facility is equipped with a V/STOL sting mount which allows $\pm 45^\circ$ pitch and yaw, a 3000 psi auxiliary air system and on-line data processing and plotting. Data are recorded with Datex, Vidar and Honeywell systems (690 channels) and reduced with an IBM 1800 system (on site).

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1941 COST \$ 392,000 ESTIMATED REPLACEMENT VALUE \$3,122,000
CONTRACTOR: Moore Dry Dock Co.	LOCATION: Oakland, California
IMPROVEMENTS AND COSTS: (1941-48) Motor generator sets, strain gauge equipment, etc., Cost \$128,000; (1949-55) Alterations, revision to scales, Cost \$69,000; (1956-60) Modification to scale systems, Cost \$5000; (1961-65) Miscellaneous, Cost \$13,000; (1966-69) Structural modifications and integral equipment, Cost \$855,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .34
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 2.4
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 172
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

NASA AMES 12-FOOT PRESSURE TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-227-5 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Assistant Director for Aeronautics and Flight Aeronautics Division Experimental Investigations Branch
OTHER SOURCES OF INFORMATION: Vol II ARC Research Facilities Summary, Dec '65	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Experimental Investigations Branch Mail Stop N-227-5 Phone: (415) 961-1111, ext 2746

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, continuous flow, single return, variable-density, low-turbulence tunnel that operates at subsonic speeds up to slightly less than Mach number 1.0. The wind tunnel is powered by a two-stage, axial-flow fan driven by electric motors totaling 12,000 horsepower. Airspeed in the test section is controlled by variation of the rotational speed of the fan. The test section is 11.3 ft in diameter and is 18-ft long. Eight fine-mesh screens in the settling chamber, together with the large contraction ratio of 25 to 1, provide an air-stream of exceptionally low turbulence.

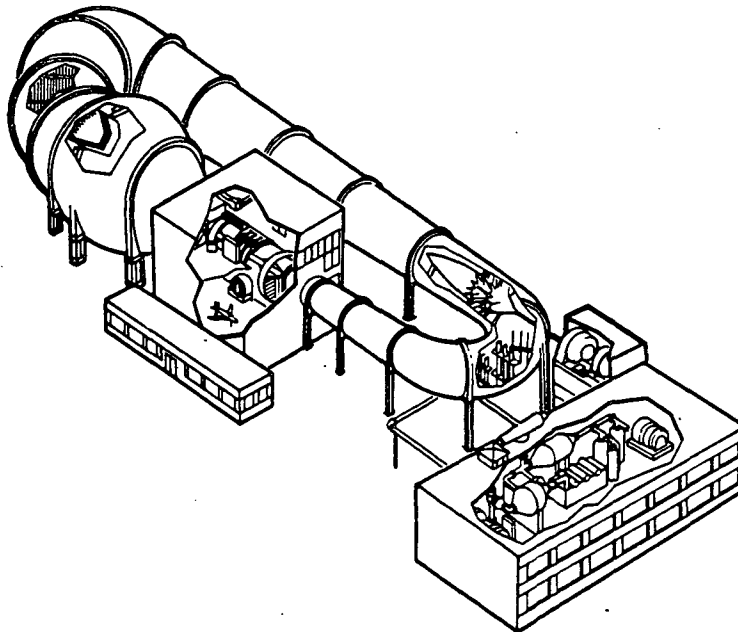
TESTING CAPABILITIES: This facility is used for testing force and moment, pressure, and dynamic stability. This tunnel is well suited for research on missile ground-wind loads. An external balance and internal strain-gage balances are available. Ground plane and semispan mounting are available with turntable movement of $\pm 20^\circ$. A special mounting drive system is available for high angle of attack. Various compact model motors and variable frequency power to drive them at variable speeds are available. There are no facilities for schlieren or shadowgraph flow visualization, but motion pictures of the test may be taken. Data are recorded on a Beckman 210 Medium-Speed recorder and processed through a centrally located Honeywell H-800 computer system.

FACILITY COST HISTORY

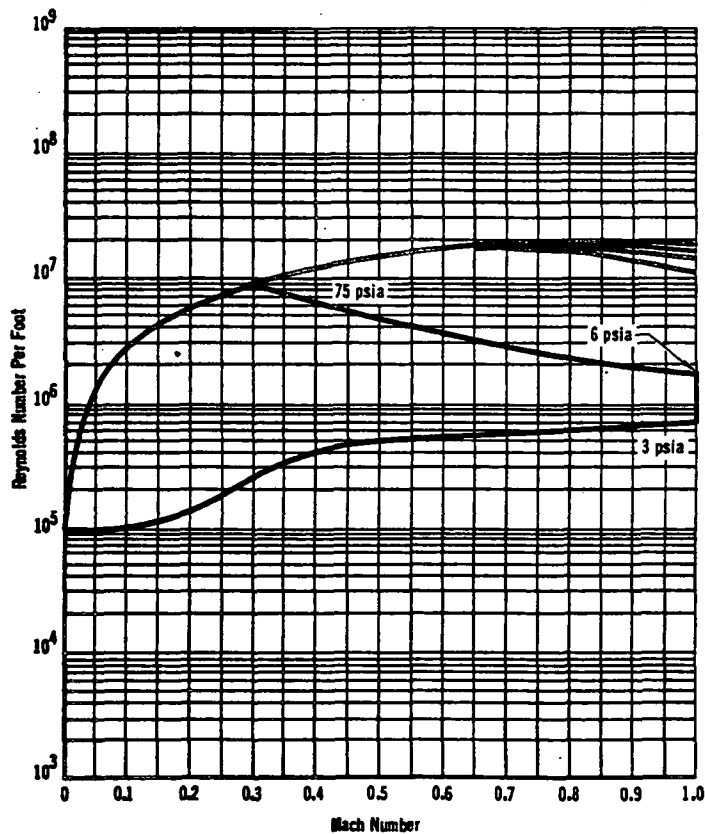
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$4000**	CONSTRUCTION YEAR: 1946 COST \$ 3,489,000 ESTIMATED REPLACEMENT VALUE \$12,914,000
CONTRACTOR: Pittsburgh Des Moines Steel Co.	LOCATION: Pittsburgh, Pennsylvania
IMPROVEMENTS AND COSTS: (1947-49) Survey apparatus; silencer, model support, cooling tower, Cost Printer, strain gage balances, safety screen, air dryer, Cost \$106,000; (1960-64) Data recorder, attitude control simulator, Cost \$411,000; (1965-69) Data acquisition system, Cost \$159,000. Others, Cost \$1,034.00.	
**Electric power and data-reduction costs which vary widely from test to test are not included.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 0 to .98
 Reynolds Number ($\times 10^6/\text{ft}$): 0 to 9
 Total Pressure (psia): 3 to 75
 Dynamic Pressure (psf): 50 to 600
 Total Temperature ($^{\circ}\text{R}$): 500 to 625
 Run Time: Continuous

NASA LANGLEY FULL-SCALE TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Flight Mechanics and Technology Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Flight Mechanics and Technology Division
OTHER SOURCES OF INFORMATION: "Characteristics of Nine Research Wind Tunnels of the Langley Aeronautical Laboratory, NACA Washington 1957": NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a continuous flow, double return, open throat type tunnel. The test section is 30 feet by 60 feet by 56 feet. Airspeed range is from 25 to 110 mph in 24 steps. A separate speed control is available permitting a continuous airspeed variation from 0 to approximately 40 mph. This facility is powered by an 8000 hp main drive.

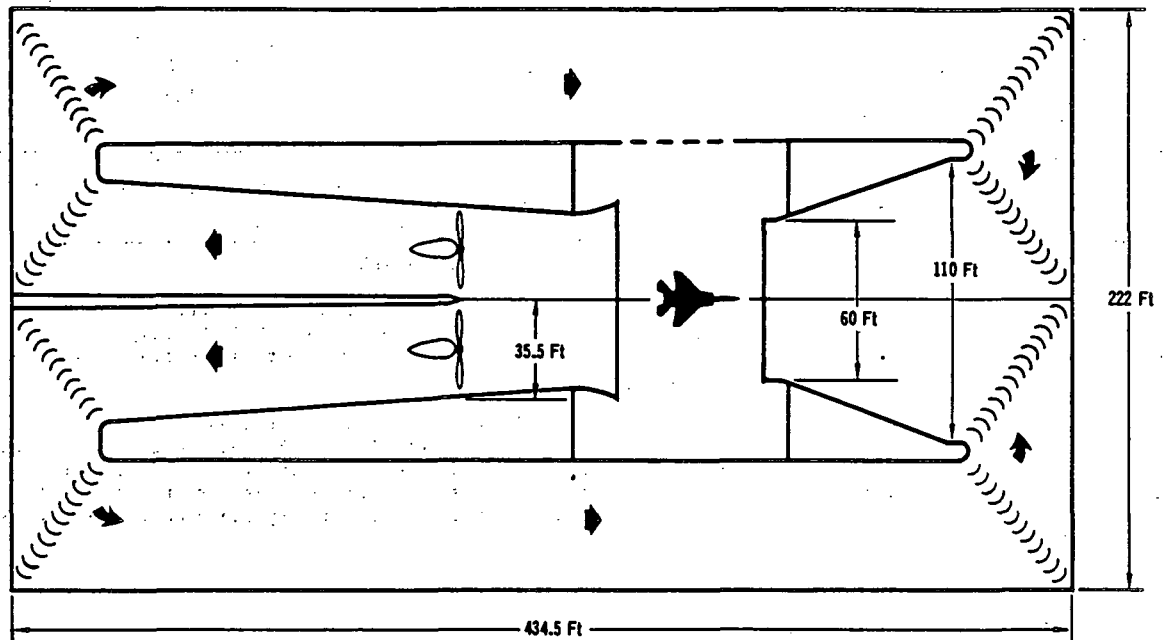
TESTING CAPABILITIES: The tunnel is equipped for free-flight dynamic model studies, and shielded struts are available for model support. A reflection plane floor 42 feet wide and 32 feet long can be installed for full scale semispan wing investigations. An auxiliary model power supply (1000 and 500 hp dc motors) and auxiliary high pressure air supply (2 lb/sec at 500 psi) are available. Data are recorded with 60 channels on a SEL data acquisition system and reduced off site. This facility can accommodate models up to 40 foot wing span and weighing 15,000 pounds.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1930 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHMATIC



FACILITY PERFORMANCE DATA

Speed Range (mph):	0-40 (Continuous); 25 to 110 (in 24 steps)
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 1
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 30
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

NASA LANGLEY V/STOL TRANSITION RESEARCH WIND TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Full Scale Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Full Scale Research Division
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow atmospheric type V/STOL tunnel. The test section is 14.5 feet high by 21.75 feet wide by 50 feet long, which can be operated as a closed tunnel with slotted walls or as one or more open configurations by removing the side walls and ceiling. The speed is variable from 0 to 200 knots. This tunnel has a contraction ratio of 9 to 1. The facility is powered by an 8000 hp main drive.

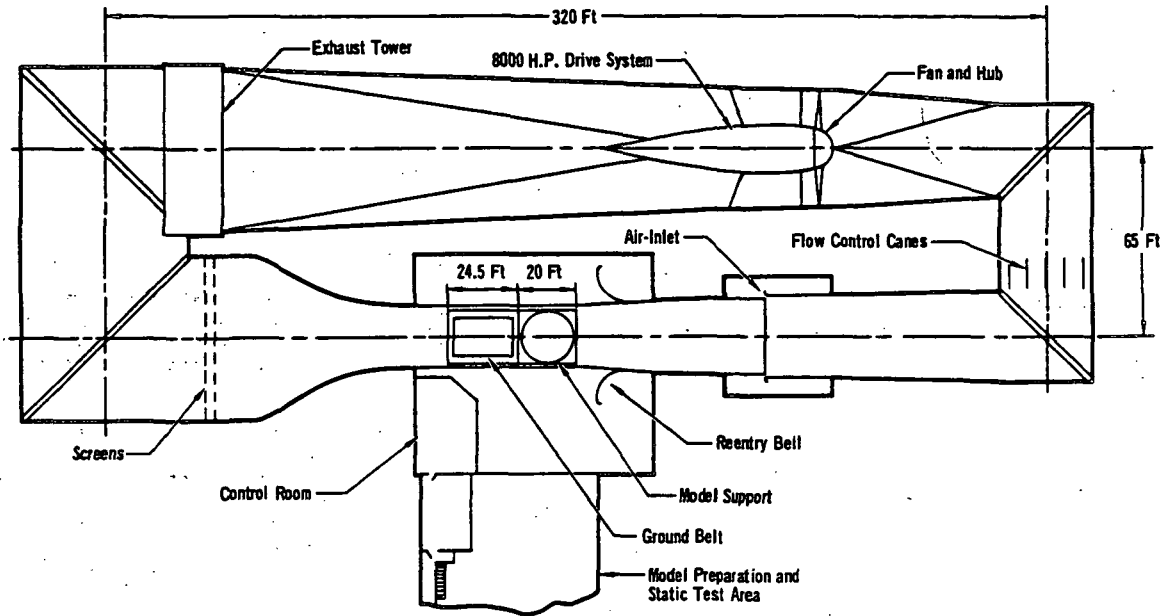
TESTING CAPABILITIES: This tunnel is capable of force, moment and pressure studies of full span and semispan powered and unpowered V/STOL, parawing and ground transport models. A moving belt ground board with boundary layer suction and variable speed capabilities for operation at test section flow velocities can be installed for ground effects tests. A universal model support system utilizes a three joint rotary sting with $\pm 45^\circ$ of pitch, $\pm 45^\circ$ of yaw and 6 feet of vertical traverse. This system is mounted on a horizontal turntable with $\pm 165^\circ$ of rotation. Models can be powered with either high pressure air (15 lb/sec at 5,000 psia) or variable frequency electric systems. Data are recorded with 60 channels and reduced off site.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1970 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .32
Reynolds Number ($\times 10^6/\text{ft}$):	0 to .55
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 135
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

NASA LANGLEY HIGH SPEED 7 BY 10-FOOT TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Full Scale Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Full Scale Research Division
OTHER SOURCES OF INFORMATION: NASA Technical Memorandum NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow, atmospheric type tunnel. The test section is 6.6 feet wide by 9.6 feet high by 10 feet long. The tunnel is cooled by an air exchange system which introduces filtered atmospheric air into the diffuser a short distance downstream from the test section. A series of four turbulence damping screens of 16-mesh wire is installed in the settling chamber. This facility is powered by a 14,000 hp main drive.

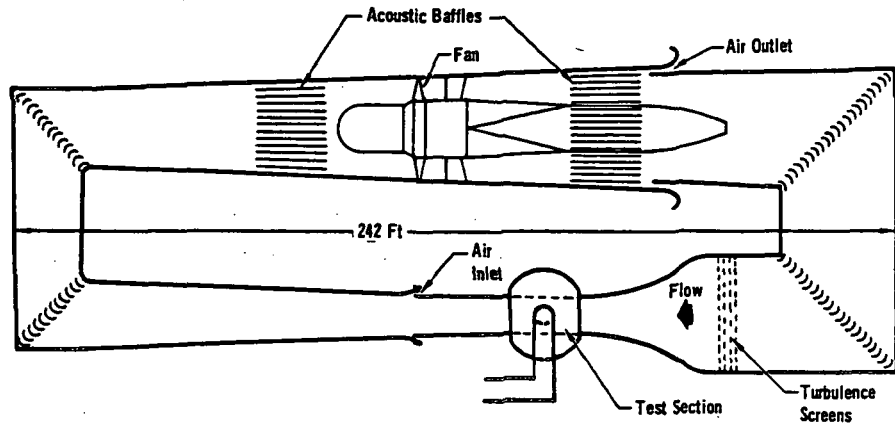
TESTING CAPABILITIES: This facility is used for static and dynamic studies of the aerodynamic characteristics of aircraft and spacecraft. Model mounting consists of sting support system, forced oscillation apparatus, and sidewall turntable. Only a limited amount of dynamic data instrumentation is available. Closed circuit television is available for monitoring tests.

FACILITY COST HISTORY

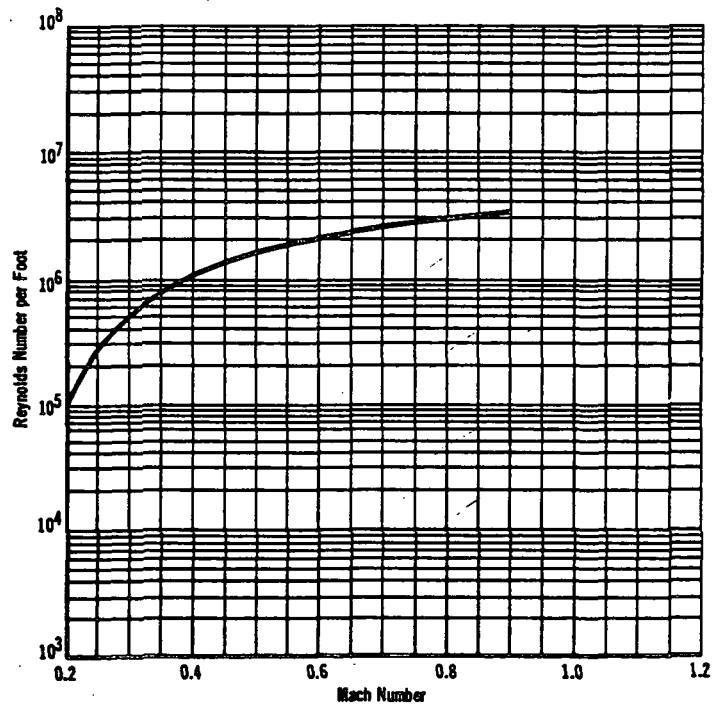
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1946 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: (1961) Transonic test section modification.	

PLANS FOR FACILITY IMPROVEMENTS: Electronic data acquisition system

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.2 to .9
Reynolds Number (x 10 ⁶ /ft):	.1 to 3.2
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	200 to 750
Total Temperature (°R):	490 to 620
Run Time:	Continuous

NASA LANGLEY LOW-TURBULENCE PRESSURE TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Full Scale Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Full Scale Research Division
OTHER SOURCES OF INFORMATION: NACA Technical Note, No. 1283, Washington, May 1947	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facility Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow type tunnel. The test section is 7.5 feet high by 3 feet wide by 7.2 feet long. The turbulence level is low due to the use of seven 30-mesh screens and a 60-mesh screen in the settling chamber, and a contraction ratio of 17.6. Temperature control is provided by a finned cooling coil located in the large section of the tunnel immediately upstream of the screens. This facility is powered by a 2000 hp main drive.

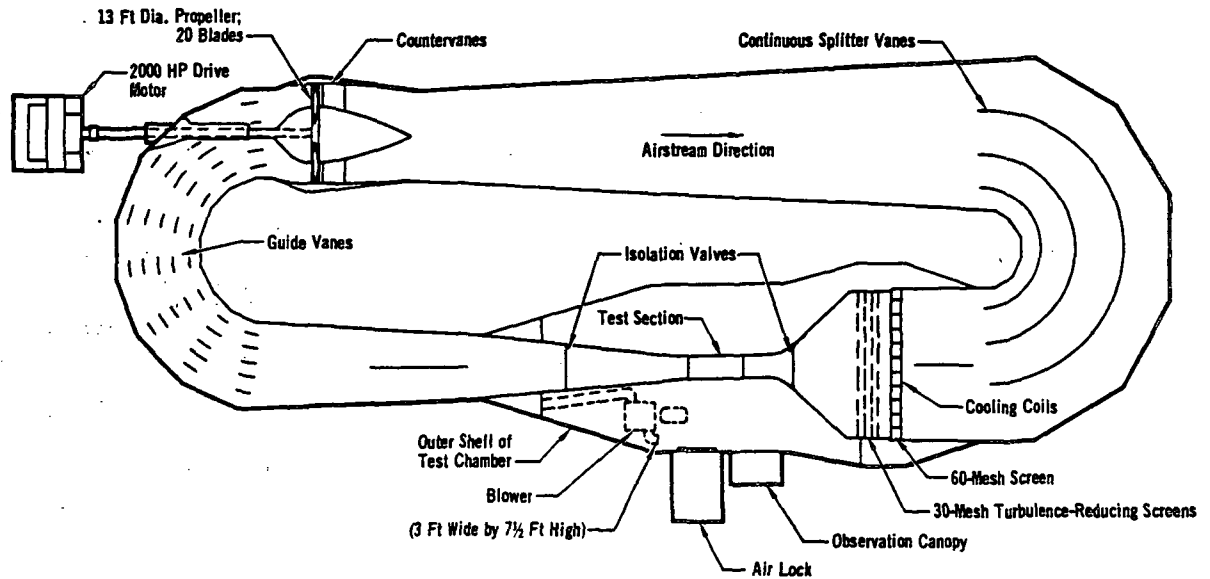
TESTING CAPABILITIES: The tunnel is particularly suited for investigation of the effects of the basic variables of shape, camber, and surface condition on airfoil, flap, and control surface characteristics at Reynolds numbers at or near flight range. Airfoil lift characteristics can be obtained by measurement of pressure reactions on the floor and ceiling of the tunnel and drag characteristics by pitot static pressure wake profiles. Moments and lift are measured with a balance. Three dimensional models are tested on a sting support using 6 component strain gauge balances to evaluate aerodynamic characteristics near landing conditions at high Reynolds numbers.

FACILITY COST HISTORY

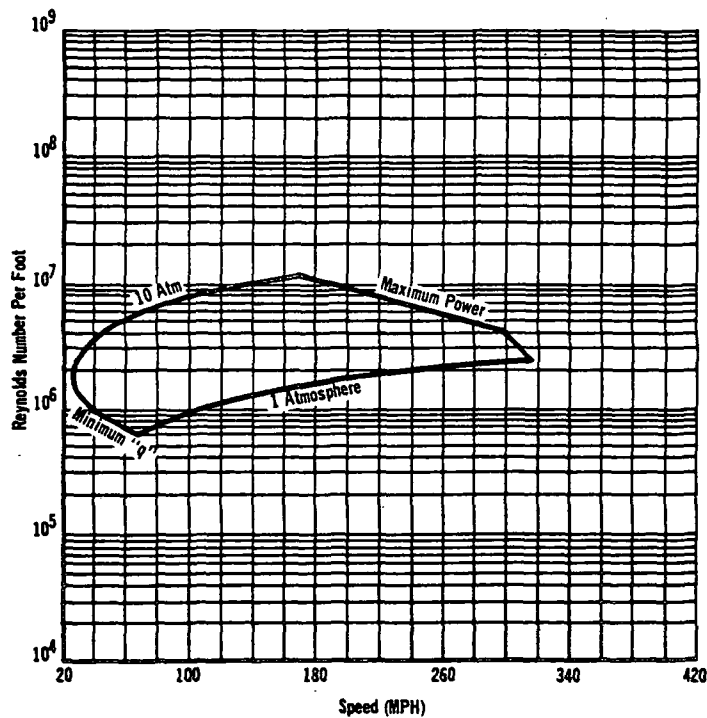
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1940 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.1 to .4
Reynolds Number ($\times 10^6/\text{ft}$):	.6 to 15
Total Pressure (psia):	10 to 150
Dynamic Pressure (psf):	23 to 785
Total Temperature ($^{\circ}\text{R}$):	520 to 560
Run Time:	Continuous

NASA LANGLEY SPIN TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Flight Mechanics and Technology Division Hampton, Virginia 23365	STATUS OF FACILITY: <u>Active</u> COGNIZANT ORGANIZATIONAL COMPONENT: Flight Mechanics and Technology Division
OTHER SOURCES OF INFORMATION: "Characteristics of Nine Research Wind Tunnels of The Langley Aeronautical Laboratory, 1957"; NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a free-spin tunnel with a closed throat and an annular return passage. The vertical test section has 12 sides and is 20 feet across the flats by 25 feet high. The test medium is air. The turbulence factor is 2. Tunnel speed is variable from 0 to 90 fps with accelerations to 15 ft/sec² and decelerations to 25 ft/sec². This facility is powered by a 1300 hp main drive.

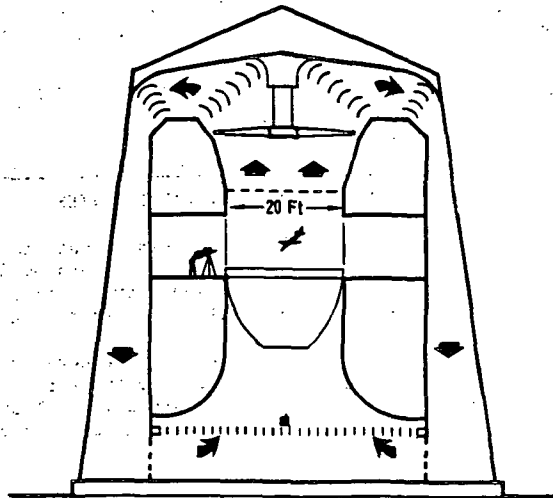
TESTING CAPABILITIES: This tunnel is used to investigate spin characteristics of dynamically scaled models. A gauss ring surrounding the test section is used to actuate spin-recovery control settings. Force and moment testing is performed using a gooseneck rotary arm model support which permits angles of attack and sideslip from 0 to 360° to be set. Data recording consists of motion pictures.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1941 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS:	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

Speed Range (feet/second):	0 to 90
Reynolds Number ($\times 10^6/\text{ft}$):	0 to .62
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 10
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

NASA LEWIS ICING RESEARCH TUNNEL

REPORTING INSTALLATION: NASA Lewis Research Center 21000 Brook Park Road Cleveland, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Chemistry and Energy Conversion Division, Applied Heat Transfer Branch
OTHER SOURCES OF INFORMATION: Technical Facilities Catalog (NASA) Vol I Report NHB8800.5, March 1967	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Applied Heat Transfer Branch Org Code: 2120 Phone: (216) 433-4000, ext 470

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This wind tunnel is a closed circuit, single return, continuous flow facility capable of controlled conditions of moisture, temperature and airspeed. This tunnel has a 6 by 9 by 20-foot test section. The facility is equipped with a steam heat exchanger, which provides 5,000,000 BTU/hr, for heating. A cooling (2100 ton) heat exchanger can provide up to -40° centigrade temperature. This facility is equipped with a 500 gallons per hour demineralizer and 450 gallon tank, which supply the necessary water to produce a 3 by 5-foot liquid water cloud in the test section. Auxiliary power sources of 115/208 volts at 200 amperes (ac) and 28 volts at 50 amperes (dc) are available. The tunnel is powered with a 4160 hp doubly fed, wound rotor electric motor capable of 0 to 540 rpm.

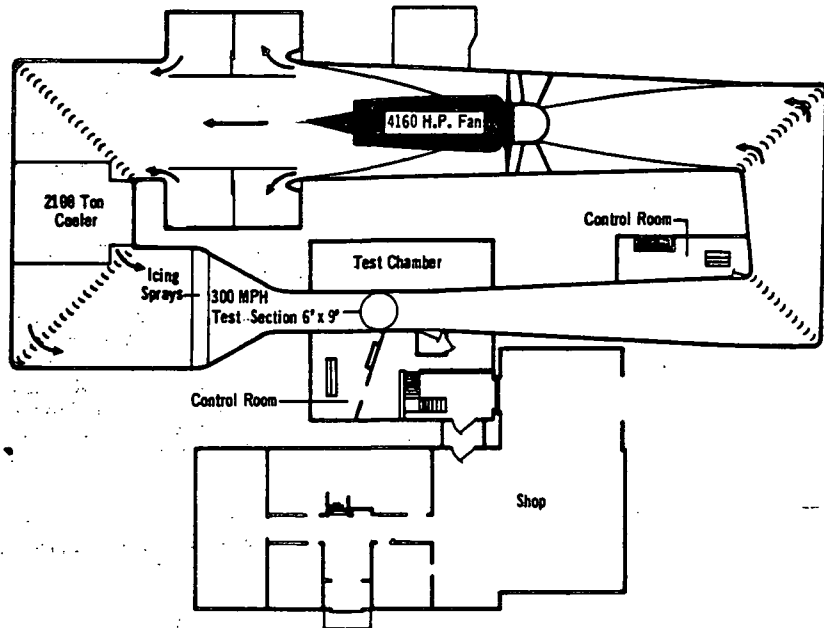
TESTING CAPABILITIES: This facility is used to investigate icing of air inlets (engines, coolers, etc.), spinners-rotating and stationary, wings, empennage surfaces, radomes, radio antennae, icing instrumentation, and temperature probes. This facility is available for aircraft industry icing tests sponsored by DOD or FAA.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1944 COST \$889,700 ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: Accumulated, Costs \$956,900	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .55
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 3.3
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 230
Total Temperature ($^{\circ}\text{R}$):	456 to 540
Run Time:	Continuous

NATIONAL BUREAU OF STANDARDS DUAL TEST SECTION SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: National Bureau of Standards Building 230 Gaithersburg, Maryland 20234	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aerodynamics Section
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mechanics Division, IBS Washington, D.C. 20234 Phone: (301) 921-2125

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is a closed circuit, single return, continuous flow, atmospheric pressure, dual test section type tunnel. One test section is of fixed size, 4 x 5 x 8 feet long; the other is 7 x 5 feet at its entrance, 40 feet long with two sidewalls continuously adjustable throughout their length to vary the test section size within the range from 3 x 7 to 7 x 7 feet to provide testing conditions with both favorable and adverse pressure gradients. Air is cooled with finned coils supplied with water. Construction of double layers of plywood on rigid steel frame. Many damping screens, acoustical liner, and large contraction ratio (25.3 to 1) are provided to assure disturbance-free air stream. The tunnel is powered by a 400 hp, variable rpm, main drive which propels an 8-foot diameter fixed pitch propeller.

TESTING CAPABILITIES: This tunnel is designed for research in stream flow properties, boundary layer flow, transitional flow, and turbulence properties. It is also used for the calibration of wind-measuring instruments. Supports are provided as required for such tests. No external balances are provided. No data recording or reduction facilities available.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$150	CONSTRUCTION YEAR: 1967 COST \$290,000* ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: E. M. Crough Company IMPROVEMENTS AND COSTS:	LOCATION: Washington, D.C.
*Estimated share of cost of Fluid Mechanics Laboratories.	

PLANS FOR FACILITY IMPROVEMENTS:

FACILITY PERFORMANCE DATA

1-49

NSRDC 8-FOOT BY 10-FOOT SUBSONIC WIND TUNNELS NOS. 1 AND 2

REPORTING INSTALLATION: Naval Ship Research and Development Center Department of Aerodynamics, Code 681 Washington, D.C. 20007	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Engineering and Facilities Division Code 680
OTHER SOURCES OF INFORMATION: Aero Report 1070	LOCAL OFFICE TO CONTACT FOR INFORMATION: Facilities Branch, Code 681 Carderock, Maryland, Building 7 Phone: (301) 995-3147

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The 8 by 10 by 14.2-foot subsonic wind tunnels are of the closed throat, single return, and continuous operation type with vented test sections. Tunnel No. 1 is powered by a 1000 hp motor and Tunnel No. 2 by a 700 hp motor. Each tunnel has a free-wheeling windmill mounted downstream from the main fan. The windmill speeds up the low energy areas. The test sections are made of wood to permit easy alterations. Most of the tunnel circuits are outside the building where they are spray cooled by a recirculating water system for temperature control. A 17 by 20-foot portion of the return passage of Tunnel No. 2 was altered to permit the testing of V/STOL models at low forward and transitional speeds, and provide the capability of performing aerodynamic studies on shrouds, ducts, and diffusers.

TESTING CAPABILITIES: These tunnels are capable of force and moment, pressure, store separation, ground plane, and flutter type tests. External mechanical balance systems are available for measurement of aerodynamic forces and moments on large models. A wide variety of internally mounted strain gage balances is also available. Auxiliary instrumentation and automatic readout equipment are available for propeller and jet powered models as well as miscellaneous components. Two variable frequency power system terminals (150 hp, 400 Hz, 1.2 volts/cycle), a high pressure air supply (2 lb/sec at 200 psi) are available for powered model testing. Models are sting, strut (single, dual, and triple) and turntable (Tunnel No. 1 only) mounted. Data are recorded with 74 channels on a Beckman 210 recorder and reduced on site with an SDS 930 digital computer.

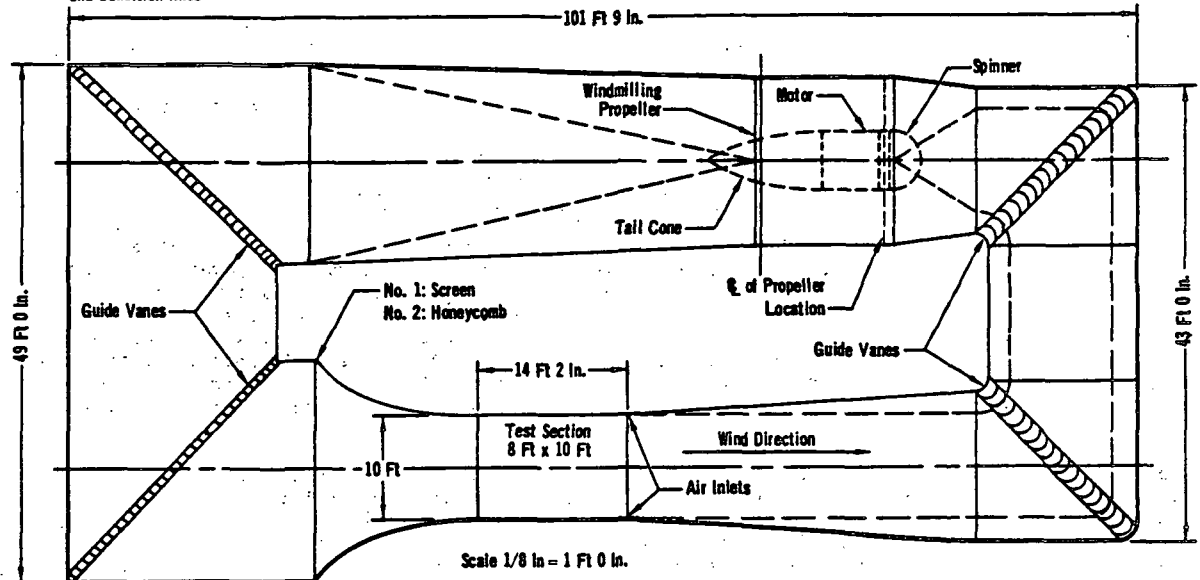
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$600	CONSTRUCTION YEAR: 1943 COST \$ 630,000 ESTIMATED REPLACEMENT VALUE \$1,600,000
CONTRACTOR: Naval Ship Research and Development Center LOCATION: Washington, D.C. IMPROVEMENTS AND COSTS:	

PLANS FOR FACILITY IMPROVEMENTS: Tunnel No. 2 is to be dismantled and the power section is to be used in a new Interim V/STOL Tunnel. It will be an open return, continuous flow tunnel with a 14.5 ft x 21.75 ft test section, with a maximum speed of 100 mph. This tunnel will be later modified to a single return tunnel with a maximum speed of 200 mph.

SCHEMATIC

Note: Dashed lines show radii tangencies and transition lines



FACILITY PERFORMANCE DATA

Tunnel Number 1

Mach Range: 0 to .29
 Reynolds Number ($\times 10^6/\text{ft}$): 0 to 1.77
 Total Pressure (psia): Atmospheric
 Dynamic Pressure (psf): 0 to 90
 Total Temperature ($^{\circ}\text{R}$): 576
 Run Time: Continuous

Tunnel Number 2

Mach Range: 0 to .25
 Reynolds Number ($\times 10^6/\text{ft}$): 0 to 1.54
 Total Pressure (psia): Atmospheric
 Dynamic Pressure (psf): 0 to 70
 Total Temperature ($^{\circ}\text{R}$): 576
 Run Time: Continuous

NORTH AMERICAN ROCKWELL/COLUMBUS SUBSONIC WIND TUNNEL WITH TANDEM V/STOL SECTION

REPORTING INSTALLATION: North American Rockwell Corporation Columbus Division 4300 East Fifth Avenue Columbus, Ohio 43216	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aircraft Research and Engineering
OTHER SOURCES OF INFORMATION: (1) Subsonic Test Facilities No. NA60H-160 (2) Airflow Laboratories V/STOL, Wind Tunnel Test Capabilities No. NA61H-814	LOCAL OFFICE TO CONTACT FOR INFORMATION: Supervisor Aerodynamic Laboratories Phone: (614) 231-1851, ext 2682

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is a closed circuit, single return, continuous flow atmospheric type facility. This tunnel utilizes a 7 by 10 by 15 foot test section downstream of a 16 by 14 by 15 foot test section for V/STOL tests built into the stilling chamber. The walls in each test section have fixed divergence to allow for boundary layer growth. Each test section has corner fillets. The tunnel is equipped with a variable rpm 2000 hp main drive which provides power to a 20-foot diameter propeller. The tunnel has a 3.44 to 1 and a 2.28 to 1 contraction ratio.

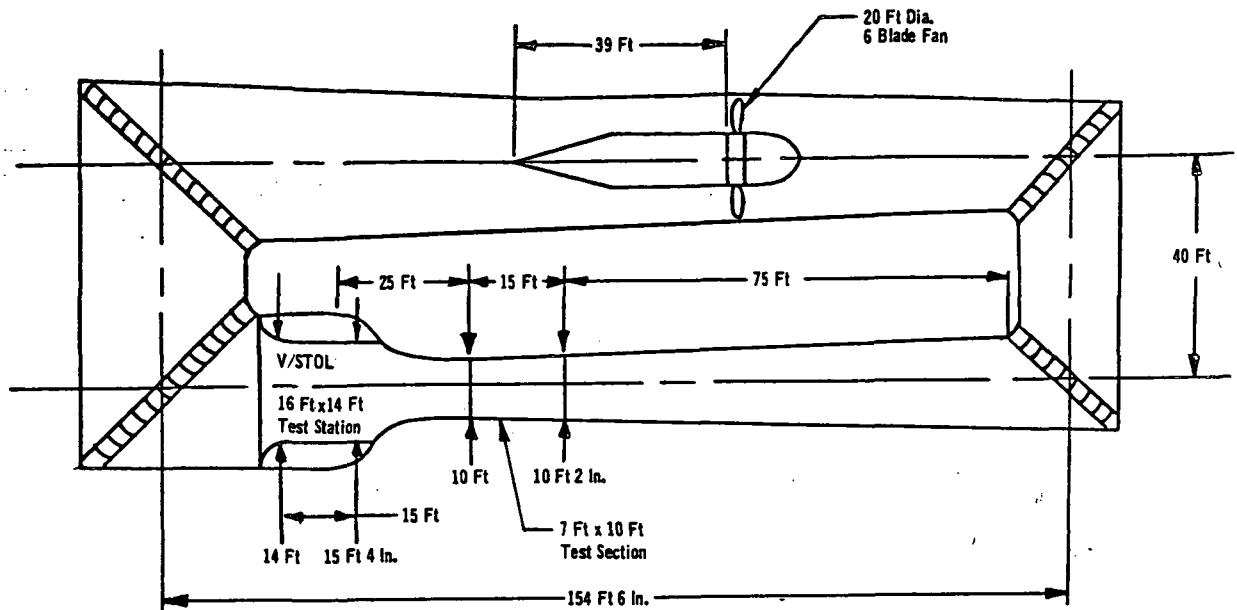
TESTING CAPABILITIES: In the 7 x 10 foot section force and moments, pressure distribution, boundary layer distribution, wake characteristics, aerodynamic loading and lift-drag relationships and interference tests are conducted. A reflection/ground plane for semispan models and insert walls for 2-D models are available. Model mounting consists of single or double strut or sting mounts. Special supports, applicable to specific tests, are available or can be produced on order. For the strut mounts a pyramidal type external balance is used while internal balances are used with the sting mount. In the 16-foot section component and complete model force, moment and pressure testing are common types of tests. Model mounting consists of vertical or slanted struts for sting mounts. Internal balances are used for these mounts. High pressure air (14 lb/sec at 450 psi); variable frequency power (100 kW, 0-350 Hz, .5-1.5 V/Hz); auxiliary evacuation system (4800 cu ft/min at ΔP of 3.9 psi), and a variable height ground board are available for use as applicable. Data are recorded and reduced on a 50 channel on site IBM 1800 plus NAR signal conditioners and amplifiers.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2800	CONSTRUCTION YEAR: 1959 COST \$1,500,000 ESTIMATED REPLACEMENT VALUE \$3,100,000
CONTRACTOR: Gresco Services LOCATION: Baltimore, Maryland IMPROVEMENTS AND COSTS: (1960) Install V/STOL liner in stilling chamber, Cost \$40,000; (1966) Isolated mounting system for V/STOL section, Cost \$22,000; (1968) On line data acquisition and processing system, Cost \$5200/month rental.	

PLANS FOR FACILITY IMPROVEMENTS: Extend the 16 foot section to obtain L/H of 2.5 estimated 18 months from go-ahead; Go ahead is expected in 1971; Tunnel downtime approximately 3 months.

SCHEMATIC



FACILITY PERFORMANCE DATA

Low Speed Section

Mach Range: 0 to .37
 Reynolds Number ($\times 10^6/\text{ft}$): 0 to 2.8
 Total Pressure (psia): Atmospheric
 Dynamic Pressure (psf): 10 to 200
 Total Temperature ($^{\circ}\text{R}$): Ambient
 Run Time: Continuous

V/STOL Section

Speed Range (mph): 20 to 85
 Reynolds Number ($\times 10^6/\text{ft}$): 0 to .85
 Total Pressure (psia): 1.1 Atmospheric
 Dynamic Pressure (psf): 1 to 18
 Total Temperature ($^{\circ}\text{R}$): Ambient
 Run Time: Continuous

NORTH AMERICAN ROCKWELL/LOS ANGELES - LOW SPEED WIND TUNNEL

REPORTING INSTALLATION: North American Rockwell Corporation International Airport Los Angeles, California 90009	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Los Angeles Division, Research and Engineering Department 056
OTHER SOURCES OF INFORMATION: Users Manual for the North American Rockwell NAAL 7.75 x 11 Foot Wind Tunnel, Report No. NA-60-1346	LOCAL OFFICE TO CONTACT FOR INFORMATION: Wind Tunnel Programs and Testing 5701 W. Imperial Hwy; Los Angeles, Calif. 90009 Phone: (213) 670-9151, ext 3421

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a continuous flow, single return, closed circuit, vented throat type tunnel. The test section is 7.75 feet by 11 feet by 12 feet. A damping screen and honeycomb section have been installed in the settling chamber upstream from the contraction cone (Ratio 7.53) to minimize turbulence in the test section. The tunnel is powered by a variable rpm 1250 hp main drive, which propels a 19-foot diameter fixed pitch propeller.

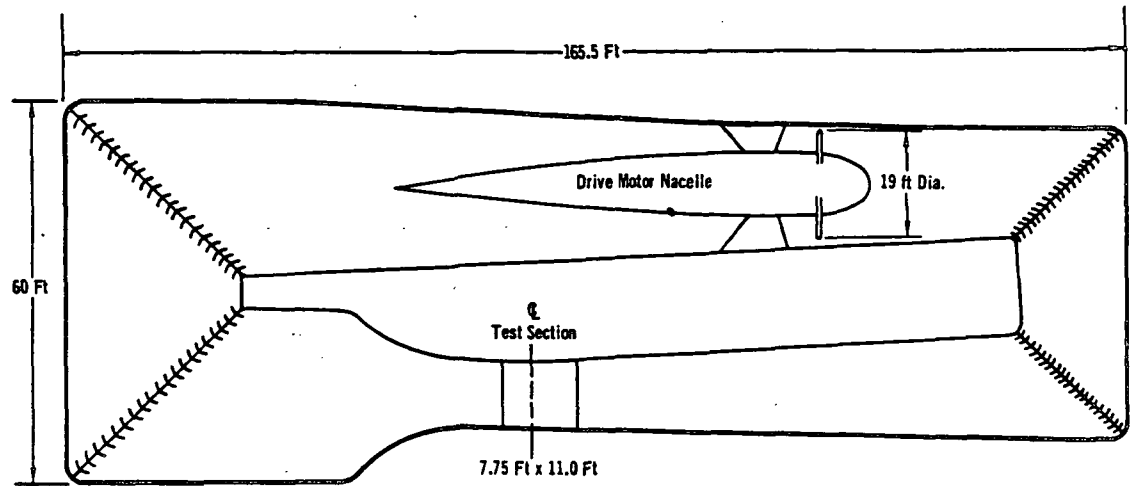
TESTING CAPABILITIES: The types of tests which may be performed include: basic force and stability, pressure distribution, flow visualization, ground plane, boundary layer control, store ejection, flutter, internal flow and nozzle studies, two-dimensional flow and dynamic stability tests. Tests may be conducted using a variety of mounting systems: single strut, double strut, sting strut, reflection plane, cable suspension, and two dimensional wall facilities. Aerodynamic data may be measured by a planar type external balance system or sting mounted internal balances. Instrumentation is available for recording 50 channels of force or pressure data on magnetic tape using the NAAL automatic data acquisition system. Additional pressure measurements may be recorded through the use of scanivalves. Data are reduced on an IBM 360-50 off site computer through an on site terminal.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1942 COST \$ 350,000 ESTIMATED REPLACEMENT VALUE \$1,500,000
CONTRACTOR: The Austin Company IMPROVEMENTS AND COSTS: (1960) Damping screen and honeycomb in settling chamber; (1961) Install new propeller blades; (1965) Astrodata automatic data acquisition system.	LOCATION: Los Angeles, California

PLANS FOR FACILITY IMPROVEMENTS: Improved Model Support System (1970); Automatic Plotter (1970)

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .28
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 2
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 120
Total Temperature ($^{\circ}\text{R}$):	570
Run Time:	Continuous

NORTHROP 7-FOOT BY 10-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: Northrop Corporation Aircraft Division 3901 W. Broadway Hawthorne, California 90250	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION: Northrop Brochure No. NB65-135, April 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (213) 675-4611, ext 2554

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This wind tunnel is a closed circuit, single return, continuous flow, atmospheric type facility. The test section is 7 by 10 by 20 feet. Functioning at ambient temperature and pressure, the tunnel provides a continuously variable air speed up to 300 mph (Mach .37) in a uniform flow throughout the test section. This facility is powered by a 2000 hp main drive.

TESTING CAPABILITIES: This facility is capable of three dimensional stability and control, pressure distribution, drag studies, external stores ejection characteristics, panel loads, propeller effectiveness, landing and ground effects, aerodynamic flutter, and inlet-internal duct type tests. Model mounting consists of single strut, sting and reflection plane type mounts. Internal strain-gage floating frame type balances are available. The tunnel balance is of the coplanar type designed to measure directly the forces and moments in the stability axis system. Pressure data are measured on manometer boards which are photographed during a test run. Using a Telereader device, raw data are read from film and translated to IBM cards for processing. Pressures may also be measured on a seven-module vacuum-reference scanivalve capable of recording 154 pressures. The electrical signals from the balances and scanivalves are recorded on an Astrodata solid state acquisition system which includes a high speed analog-to-digital conversion unit and magnetic tape recording units. Data are recorded on an on-site Honeywell DDP 516 computer. Data may be plotted on an on-site Calcomp plotter controlled by the DDP 516 computer.

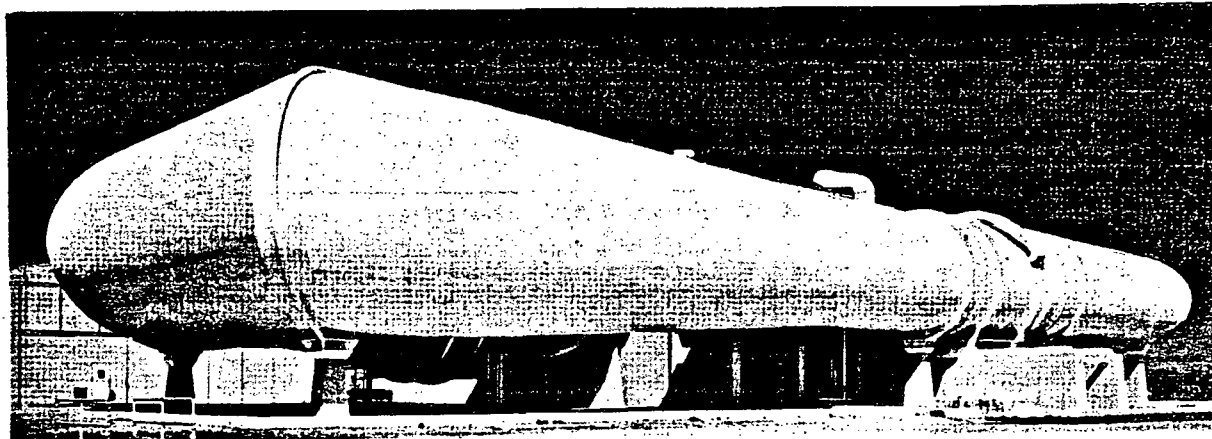
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None

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SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .37
Reynolds Number ($\times 10^6/\text{ft}$):	.4 to 2
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 200
Total Temperature ($^{\circ}\text{R}$):	540 to 580
Run Time:	Continuous

TEXAS A&M 7-FOOT BY 10-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: Texas A&M University Aerospace Department College Station, Texas 77843	STATUS OF FACILITY: Active
	COGNIZANT ORGANIZATIONAL COMPONENT: Space Technology Division
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Space Technology Division Phone: (713) 845-4531

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is a continuous flow, single return, closed circuit, atmospheric type low speed wind tunnel. The test section is 7 feet by 10 feet by 16 feet. This facility is powered by a 1250 kVA, (1200 hp), synchronous electric motor which drives a 12-1/2-foot diameter propeller. Cooling of the tunnel is accomplished by spraying the outer tunnel shell with water. The tunnel has a contraction ratio of 10.4 to 1.

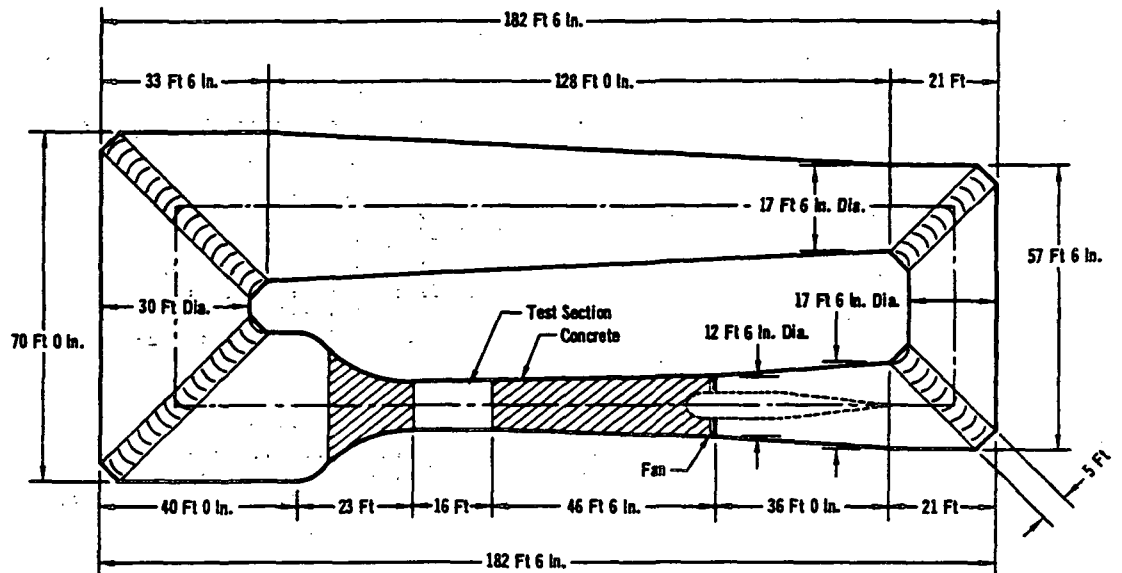
TESTING CAPABILITIES: Most subsonic aerodynamic test programs may be accommodated in this wind tunnel. The test section incorporates an external pyramid balance system which separates and independently measures the aerodynamic components of lift, drag, side force, pitching moment, rolling moment and yawing moment. Model mounting consists of single and triple strut type support systems. An auxiliary air supply (100 cfm at 3190 psi) is available. Data are recorded with six selsyn actuated indicators and reduced on an IBM 360/65 computer.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$800	CONSTRUCTION YEAR: COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: (Not available.)	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: To provide an analog output from the selsyn indicators.

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .25
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 1.9
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 100
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

UNITED AIRCRAFT ACOUSTIC RESEARCH TUNNEL

REPORTING INSTALLATION: United Aircraft Research Laboratories Silver Lane East Hartford, Connecticut	STATUS OF FACILITY: Active 15 June 1970 COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: United Aircraft Research Laboratory, Fluid Dynamics Department Phone:

DESCRIPTION AND TESTING CAPABILITIES

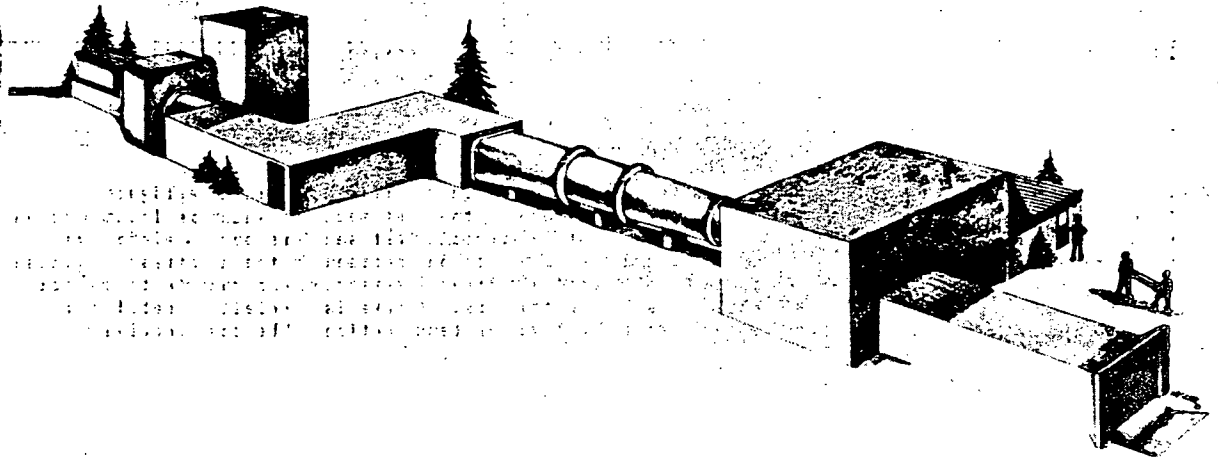
FACILITY DESCRIPTION: This open-return, free jet tunnel is designed specifically to investigate a variety of aerodynamic noise phenomena. Air is drawn through the test section, which is located in an anechoic room, at speeds up to 600 feet per second. Interchangeable test sections permit airfoil and blade models or complete small-scale compressor and fan models to be immersed in the airstream. Because of the free-jet arrangement, noise generated by the model-airstream interaction can radiate to the far field and be detected by microphones located at selected stations. Intake is specially treated with screen and honeycomb material to provide low turbulence level in test section. The test section is 2.5-4.5 by 2.5-4.5 by 4-feet.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: (Not Available)	

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



FACILITY PERFORMANCE DATA

Speed Range: 600 ft/sec
Reynolds Number ($\times 10^6/\text{ft}$):
Total Pressure (psia): Atmospheric
Dynamic Pressure (psf):
Total Temperature ($^{\circ}\text{R}$): Ambient
Run Time:

UNITED AIRCRAFT 4-FOOT BY 6-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: United Aircraft Research Laboratories Silver Lane East Hartford, Connecticut 06108	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: United Aircraft Research Laboratories, Test Facilities
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Test Facilities, United Aircraft Research Laboratories Phone: (203) 565-6268

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit single return, continuous flow atmospheric tunnel. The test section is rectangular 4 by 6 by 6-feet with fillets in the corners and operates at a maximum velocity of 110 mph and at atmospheric pressure. Turbulence factor on the tunnel centerline is 1.32 and the tunnel has a contraction ratio of 3.61 to 1. The tunnel is powered by a 75 horsepower main drive, which powers a 7.5-foot diameter propeller.

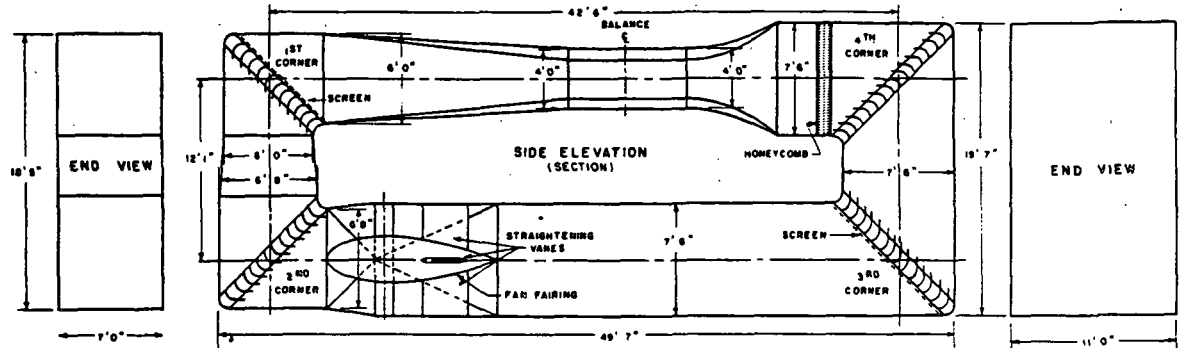
TESTING CAPABILITIES: The tunnel is equipped with an external 6 component balance. Standard model mounting systems consist of two or three strut support systems. Special systems can be fabricated on need. Data acquisition is manual with a Univac 1108 computer system (on site) available for reduction.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: (Not Available)	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .14
Reynolds Number ($\times 10^6/\text{ft}$):	0 to .8
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	5 to 31
Total Temperature ($^{\circ}\text{R}$):	520 to 590
Run Time:	Continuous

UNIVERSITY OF MARYLAND SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: University of Maryland College Park, Maryland 20742	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Wind Tunnel Operations Department
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Wind Tunnel Operations Department Phone: (301) 454-2413

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow tunnel. The test section is 7.75 feet by 11 feet by 15 feet with corner fillets. The airflow is provided by a variable speed fan with a 1750 HP main drive. Cooling is accomplished by water circulating through the corner turning vanes.

TESTING CAPABILITIES: This facility is capable of any type subsonic test except sting mount and moving belt ground plane. Test with aircraft, helicopters, ground effect, vehicles, cars, trucks, antennas, buildings, parachutes, ordnance, ships, cable problems, lighting fixtures, building materials and others have been tested at this facility. The tunnel has a six-component yoke type balance located beneath the test section. The tunnel is capable of handling power (200 hp, 0-400 Hz, .25-1.5 volts/cycle) model motors. An adjustable ground board can be installed for obtaining ground proximity effects data. An auxiliary high pressure air supply (100 psi, .5 lb/sec) is available. The tunnel is equipped with an evacuation system which can remove 2.5 lb/sec at 90% vacuum. Test section has good visibility for photographic studies. Up to five 48 port scanivalve sequential pressure scanning system, data recorded on punched cards. Two dimensional test section inserts available (3 ft x 7.75 ft test section) but without wall BLC. Data are recorded using 250 channels for pressure and 48 strain gage channels, all on punch cards and then reduced on IBM 1620, IBM 7094, Univac 1108 systems.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1,400	CONSTRUCTION YEAR: 1947 COST \$1,250,000 ESTIMATED REPLACEMENT VALUE \$2,500,000
CONTRACTOR: Austin Company LOCATION: New York, New York IMPROVEMENTS AND COSTS: (1955) BLC air supply system, Cost \$13,241; (1962) Strain gage, sequential scanner - 48 channel, Cost \$18,965; (1963) A-D conversion and recording system replaced with solid state, Cost \$17,898; (1966) Loading dock lift platform, Cost \$6,170; Others plus total through 1969, Cost \$57,274.	

PLANS FOR FACILITY IMPROVEMENTS: Install high speed yaw system, sting support system, improved strain gage data acquisition system for both static and dynamic loads, improved BLC high pressure air system.
NOTE: No idea when any of these will be available.



Mach Range:	0 to .32
Reynolds Number (x 10 ⁶ /ft):	0 to 2.06
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 102.4 (with model)
Total Temperature (°R):	530
Run Time:	Continuous

UNIVERSITY OF MICHIGAN 5-FOOT LOW SPEED WIND TUNNEL

REPORTING INSTALLATION: University of Michigan North Campus Ann Arbor, Michigan 48105	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Department of Aerospace Engineering
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Gas Dynamics Laboratories Phone: (313) 764-8224

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow, atmospheric tunnel. The test section is 5 feet by 7 feet by 25 feet. An auxiliary air supply at 2500 psi is available. The tunnel has a contraction ratio of 15:1 and a free stream turbulence level as low as .02%. The tunnel has no heat exchanger, so that the air temperature depends on weather conditions and power input. The tunnel is powered by a variable rpm 1000 hp main drive which propels a 10-foot diameter fixed pitch propeller.

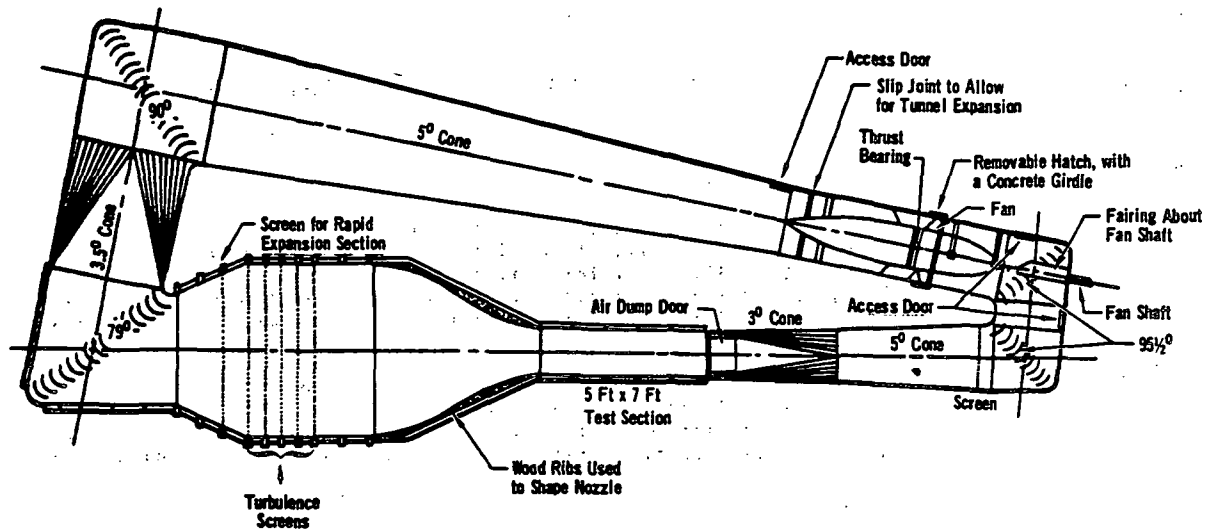
TESTING CAPABILITIES: The tunnel is equipped with an external six-component strain gage balance, with connection to models through a vertical strut through the tunnel floor. Instrumentation is available for measurement and analysis of fluctuating velocities and pressures, including 11 constant temperature and two constant-current hot-wire anemometers, FM magnetic tape recorders with nine channels, and an analog computer.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$450	CONSTRUCTION YEAR: 1956 COST \$235,000 ESTIMATED REPLACEMENT VALUE \$500,000
CONTRACTOR: University of Michigan	LOCATION: Ann Arbor, Michigan
IMPROVEMENTS AND COSTS: (1957) 6-Component balance system, Cost \$5000; (1960) Exciter, Cost \$2000.	

PLANS FOR FACILITY IMPROVEMENTS: Balance readout equipment.

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .26
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 2.0
Total Pressure:	Atmospheric
Dynamic Pressure (psf):	0 to 100
Total Temperature:	Ambient
Run Time:	Continuous

UNIVERSITY OF WASHINGTON 8-FOOT BY 12-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: University of Washington Seattle, Washington 98105	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: College of Engineering Department of Aeronautics and Astronautics
SOURCES OF INFORMATION: UWAL Wind Tunnel Brochures	LOCAL OFFICE TO CONTACT FOR INFORMATION: William H. Rae, Jr., Associate Director Phone: (206) 543-0439

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The tunnel is a closed circuit, double return, continuous flow facility with the test section vented to the atmosphere. The test section is 8-feet by 12-feet with 1.5 foot corner fillets and is 10-feet long. Power is supplied by two synchronized, electrically driven propellers, one in each return duct. The tunnel is used for research and is available to industry for research and development testing. The tunnel is powered by a variable rpm 1000 hp main drive, which propels a fixed pitch 14.75 foot propeller. This tunnel has a contraction ratio of 6:1.

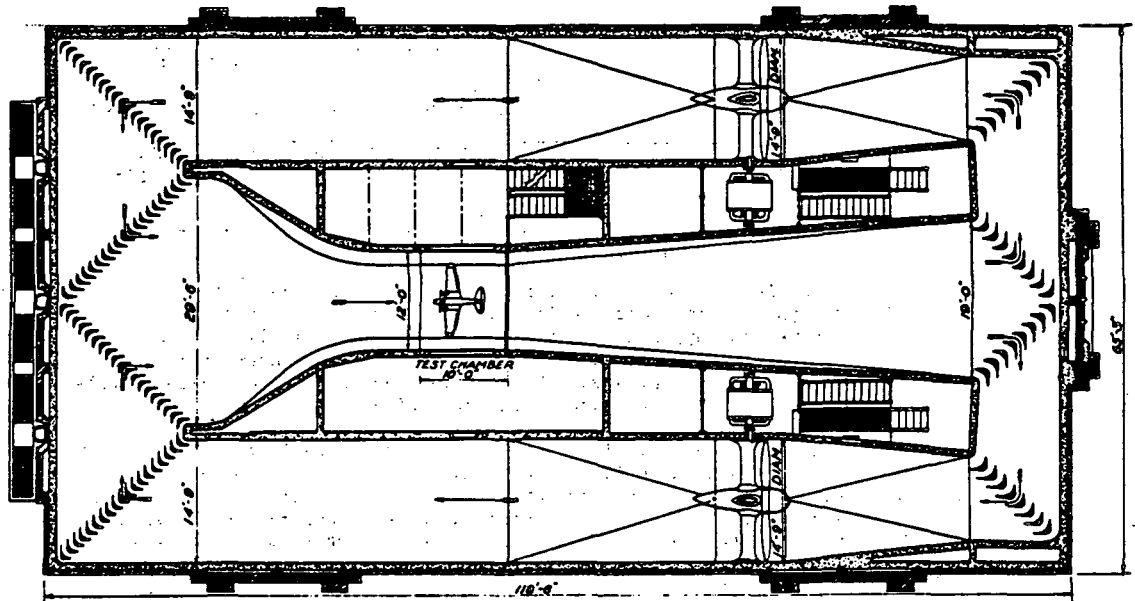
TESTING CAPABILITIES: The model mounting provisions and balance system enable testing over a wide range of pitch and yaw angles with rapid positioning for any combination of angles. The balance system provides simultaneous six-component measurements and measures all forces and moments with respect to the wind axis at the balance moment center located on the tunnel axis. The balance output is simultaneously punched out on IBM cards, typed on data sheets and plotted in coefficient form on automatic plotters. If desired for drop, flutter tests, etc., the balance strut and fairing may be removed from the test section. Special mounts may be built to attach to either the balance or the test section floor or ceiling when desired. The following auxiliary test equipment is available: two, three phase variable frequency generators with an output of 125 kVA at .8 power factor. Maximum frequency is 450 hertz, volts/cycle .75 to 1.50. A ten channel auxiliary readout system with a digital output on IBM cards, with ten 36 port Scanivalves are available with 2.5 and 5.0 psi transducers. In January 1971, a high pressure auxiliary air supply will be available. This system will be capable of delivering 10 lbs/sec up to 3000 psi, for 12 minutes. The system consists of a compressor and storage tanks.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$800 to \$1,000 (No Air)	CONSTRUCTION YEAR: 1939 COST \$ 250,000 ESTIMATED REPLACEMENT VALUE \$4,000,000
CONTRACTOR: Not known IMPROVEMENTS AND COSTS: (1953) New balance, Cost \$70,000; (1961) New improved design propellers, Cost, \$30,000; (1962) Automatic balance readout system, Cost \$70,000; (1963) Auxiliary model motor power supply, Cost \$50,000; (1969) Ten channel auxiliary readout system, Cost \$50,000; Others, Cost \$40,000.	

PLANS FOR FACILITY IMPROVEMENTS: Auxiliary Air Supply in operation January 1971; Estimated Cost \$520,000. Propose to extend bellmouth to make large Low Speed V/STOL Test Section.

SCHEMATIC



FACILITY PERFORMANCE DATA

Mach Range:	0 to .27
Reynolds Number (x 10 ⁶ /ft):	0 to 1.8
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	1 to 160
Total Temperature (°R):	Ambient
Run Time:	Continuous

WICHITA STATE 7-FOOT BY 10-FOOT SUBSONIC WIND TUNNEL

REPORTING INSTALLATION: Wichita State University Aeronautical Engineering Department Wichita, Kansas 67208	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Dean of Engineering, Wichita State University
OTHER SOURCES OF INFORMATION: Information for users of the W.S.U., LSWT, July 1966	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. Marvin Davidson, W.S.U. Phone: (316) 685-9161, ext 314

DESCRIPTION AND TESTING CAPABILITIES

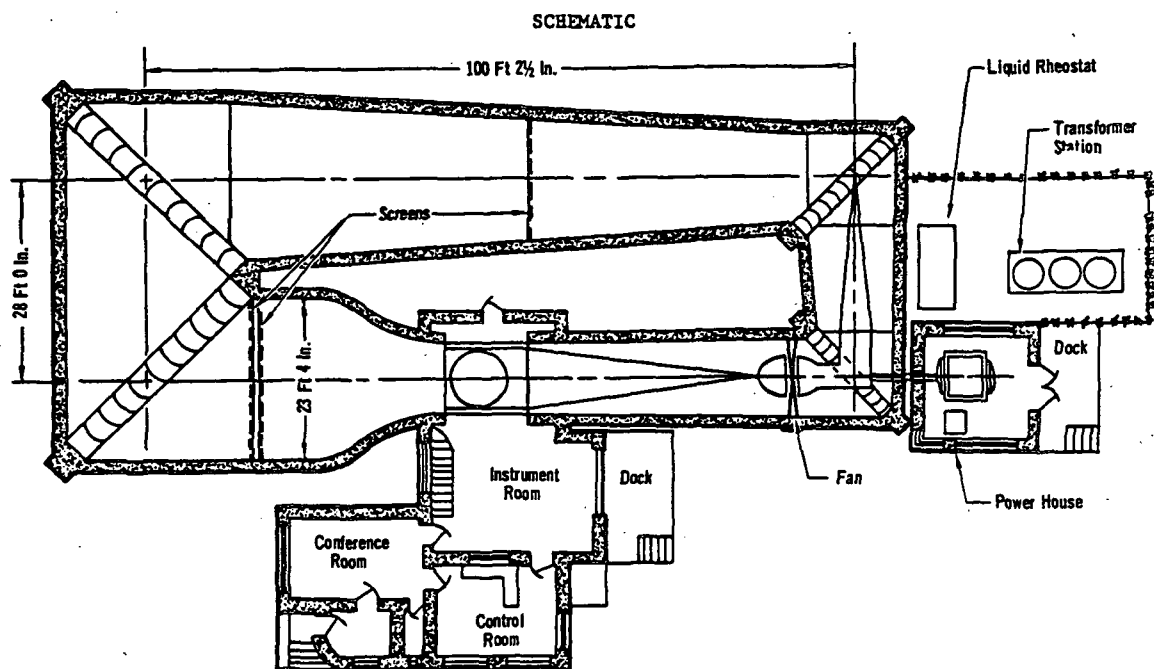
FACILITY DESCRIPTION: This is a single return, closed circuit, continuous flow type tunnel. The test section is 7 feet by 10 feet by 12 feet. The tunnel has a contraction ratio of 6 to 1. This facility is powered by a 1500 hp main drive.

TESTING CAPABILITIES: The tunnel has been used for force and moment, pressure, flutter and inlet testing. The tunnel is equipped with a six component, pyramidal balance that is located below the test section. The model mounting systems include one-, two- and three-strut support, plus many others such as reflection plane. An auxiliary model motor power supply, (60 kVA, 0 to 480 cps, 1.2 V/cycle), is available. Data are recorded on seven channels using a digital servosystem with an IBM 526 and are reduced with an on site IBM 1130 and 1620 system.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$600	CONSTRUCTION YEAR: 1947 COST \$155,000 ESTIMATED REPLACEMENT VALUE \$ 2 to 3 Million
CONTRACTOR: University of Wichita, Dept of Engineering LOCATION: Wichita, Kansas IMPROVEMENTS AND COSTS: (1949) Six component external balance, Cost \$75,000; (1952) Conversion from gasoline to electric fan drive, Cost \$41,000; (1954) Installation of variable freq model motor system, Cost \$25,000; (1959) Installation of new data system, Cost \$20,000; (1962) Replace test section, Cost \$10,000; Others, Cost \$30,000.	

PLANS FOR FACILITY IMPROVEMENTS: Rebuild or replace present data system. Install auxiliary air and evacuation system.



FACILITY PERFORMANCE DATA

Mach Range:	0 to .3
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 1.6
Total Pressure (psia):	14.7 to 15.3
Dynamic Pressure (psf):	0 to 90
Total Temperature ($^{\circ}\text{R}$):	Ambient
Run Time:	Continuous

C.2. TRANSONIC/SUPERSONIC WIND TUNNELS

AEDC TRANSONIC/SUPERSONIC WIND TUNNELS

REPORTING INSTALLATION: Arnold Engineering Development Center (AEDC) Arnold Air Force Station, Tennessee 37389	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Air Force Systems Command
OTHER SOURCES OF INFORMATION: Test Facilities Handbook, AEDC 8th Edition, December 1969	LOCAL OFFICE TO CONTACT FOR INFORMATION: Director of Test (AET) Phone: (615) 455-2611, ext 625 or 645

INFORMATION ON THE FOLLOWING FACILITIES:

Propulsion Wind Tunnels (PWT-16S, 16T & 4T)
Supersonic Wind Tunnel (A)

IS SUBJECT TO SPECIAL EXPORT CONTROLS. FURTHER INFORMATION MAY BE OBTAINED FROM:

Air Force Systems Command
Arnold Engineering Development Center
Arnold Air Force Station, Tennessee 37389

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AFFDL 2-FOOT SUPERSONIC GASDYNAMIC FACILITY

REPORTING INSTALLATION: Air Force Flight Dynamics Laboratory (AFFDL) Wright-Patterson AFB Ohio 45433	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Flight Mechanics Division (FDM) Aeromechanics Branch (FDMM)
OTHER SOURCE OF INFORMATION: Brochure: "The Two-Foot Supersonic Gasdynamic Facility", August 1, 1968	LOCAL OFFICE TO CONTACT FOR INFORMATION: Aeromechanics Branch (FDMM) Phone: (513) 255-5661 or -5564

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The 2 ft high by 2 ft wide SGF is a closed circuit, variable density, continuous flow facility used for supersonic testing. A variation in Mach number is provided through the utilization of fixed nozzle blocks. The Mach number blocks available are 1.50, 1.89, 2.30, 3.00, 4.76. The air is driven in the circuit by a ten stage axial flow compressor. This compressor provides the necessary compression ratio for all Mach numbers up to Mach 3.00. For Mach 4.76, the facility compressor is connected in series with compressors in an adjacent building.

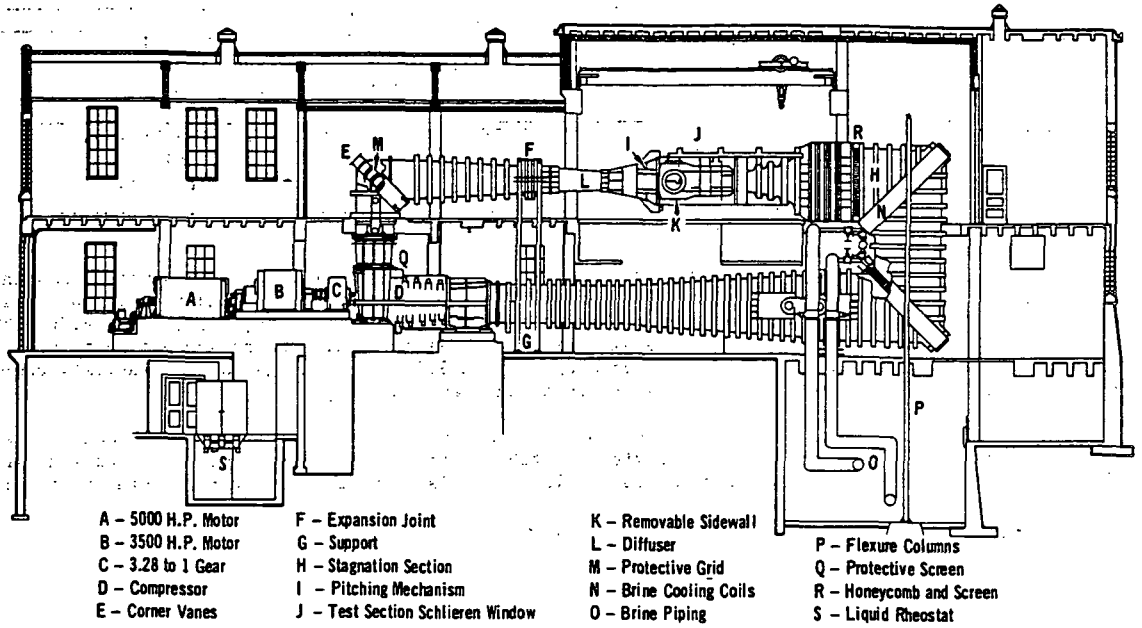
TESTING CAPABILITIES: The tunnel is used for force and moment, and pressure tests. The models are supported from a sting-crescent type mount with a pitch and roll capability. Schlieren and shadowgraph systems are available. The data are recorded on (129 channels) IBM cards and reduced via an off site IBM 7094 computer.

FACILITY COST HISTORY

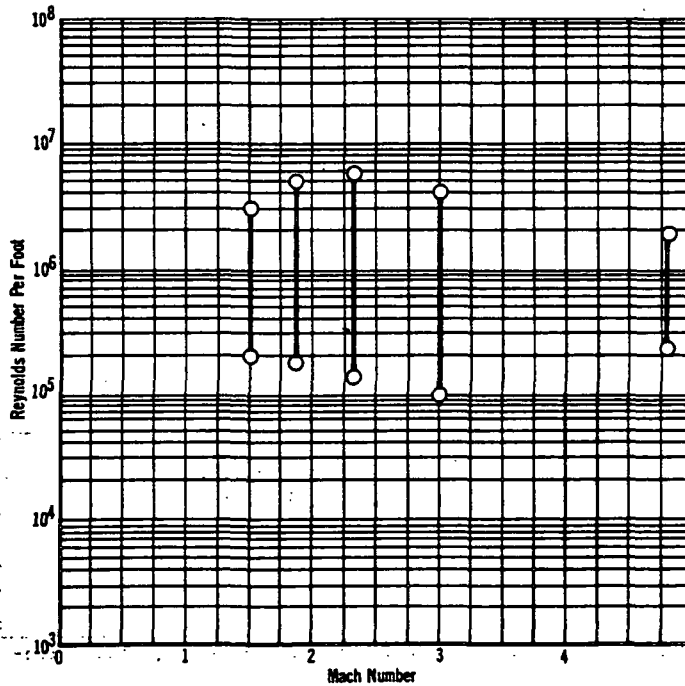
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not available	CONSTRUCTION YEAR: 1943 COST \$1,250,000 ESTIMATED REPLACEMENT VALUE \$4,000,000
CONTRACTOR: Pittsburgh-Des Moines Steel Co.	LOCATION: Pittsburgh, Pa.
IMPROVEMENTS AND COSTS: (159) Motor and drive addition, Cost \$200,000.	

PLANS FOR FACILITY IMPROVEMENTS: Transonic insert in test section area. This insert will provide transonic testing capability. The supersonic testing capability will be retained.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	1.5, 1.89, 2.3, 3, 4.76
Reynolds Number ($\times 10^6/\text{ft}$):	.1 to 5.6
Total Pressure (psia):	.7 to 29.2
Dynamic Pressure (psf):	40 to 1100
Total Temperature ($^{\circ}\text{R}$):	559
Run Time:	Continuous

BRL SUPERSONIC WIND TUNNEL NO. 1

REPORTING INSTALLATION: Ballistics Research Laboratories Exterior Ballistics Laboratory Aberdeen Proving Ground, Maryland 21005	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Wind Tunnels Branch, Exterior Ballistics Laboratory
OTHER SOURCES OF INFORMATION: Report No. BRL-MR 1292, July 1960 BRL-MR1731, February 1966	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. Robert H. Krieger, Chief, Wind Tunnels Branch Mr. Bush, Chief, Operations Section, Wind Tunnels Branch; Phone: (301) 278-4773

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow, variable density supersonic wind tunnel with a 15-inch high by 13-inch wide test section. The nozzles are formed by upper and lower flexible plates between parallel sidewalls. The flexible plate adjustment is semiautomatic and the sidewalls are completely removable. Mach numbers from 1.25 through 5.0 have been established at every one-fourth Mach number increment over the complete range. Typical Mach number uniformity throughout the testing region flow field is $M < \pm .02$ and in the majority of cases is $M < \pm .01$. Flow inclination is typically $\epsilon < \pm .1$ degree. Supply section screens and contraction fairings ensure low turbulence factors (approximately 1/4%). Air humidity is closely controlled to specific humidity $< .0002$ but supply temperature upper bound limits air constituent liquefaction-free conditions to $M < 4.5$ -depending somewhat on supply pressure. A variable supersonic diffuser has been developed which provides quick and easy starting of all Mach number flows. The compressor plant (No. 1) is a flexible arrangement of five centrifugal flow machines which are staged in any one of four major configurations to supply the varied requirements of this or two other tunnels. (Plant No. 1 also becomes the first three stages of air compression for the BRL Hypersonic Wind Tunnel No. 4.) A separate Roots compressor is used for subatmospheric tunnel starts and continuous low pressure operation. Make-up process air is dried and stored in a 17,000 ft³ storage sphere at up to 80 psia. Large quantities of high pressure auxiliary air is continuously available for simulation of jet and rocket exhausts.

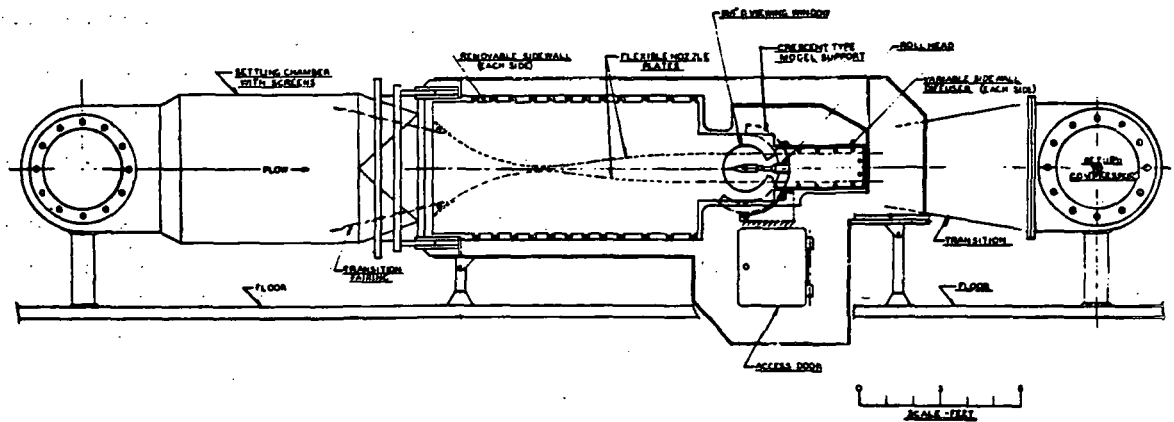
TESTING CAPABILITIES: This facility is capable of: force and moment (static), pressure distribution, jet interaction and rocket exhaust, Magnus and spin damping, pitching in pitch, temperature distribution, drag vs spin, flow turbulence, shock wave interaction, air liquefaction, flow surveys (Mach distribution, flow direction, boundary layer gradient) types of testing. Models are supported from an angle of attack arc with a pitch range of -10 to +15 degrees. Angular offsets are employed to extend the normal excursion. A 280 degree range roll strut socket is used for remote control of model roll attitude. A limited amount of remote controlled model yaw can also be employed to adjust aerodynamic zero yaw of yaw sensitive ballistic models. Axially variable drives and floor or wall mounts are also available and two-dimensional airfoils have been mounted between the test section windows. Pressure and electrical-signal-scanning auxiliary equipment is used as required to match or condition model inputs to data readout instrumentation capabilities. An 8-channel analog-to-digital data acquisition system is shared with BRL Wind Tunnel No. 3 and a new 50-channel high speed data acquisition system is centrally located for use by all the BRL Wind Tunnels. Data format includes tabulation of raw data and paper tape and/or magnetic tape raw data storage. A large central computer is used to refine the raw data acquired by all the BRL laboratories as well as for purely theoretical computations. Flow visualization is by schlieren (black and white, color, still, or 16mm normal speed or high speed motion), shadowgraph, interferometric or oil flow technique. Tuft studies are also made of model wake flows. Many kinds of laboratory instruments are on-hand or available in the U.S. Army Aberdeen Proving Ground complex as are the services occasionally required when unusual experiments are undertaken.

FACILITY COST HISTORY

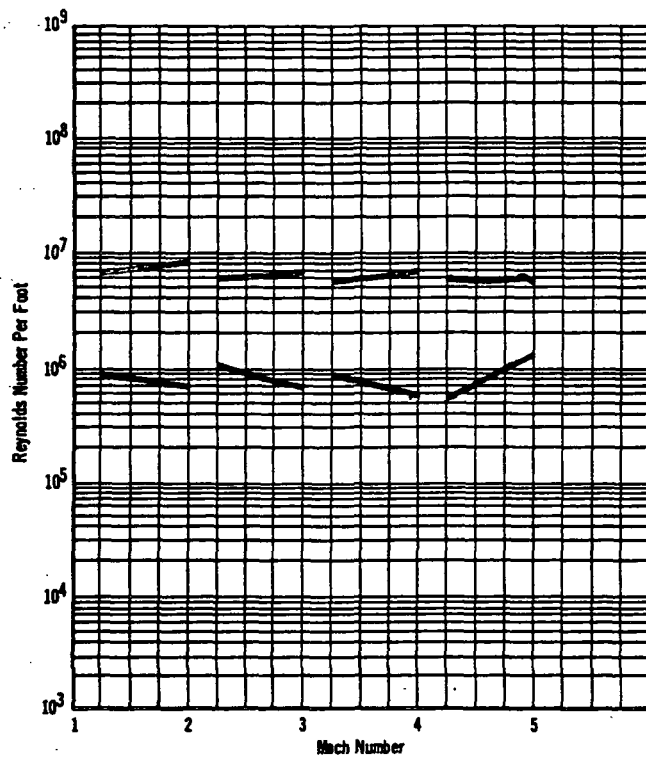
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$5600	CONSTRUCTION YEAR: 1954 COST \$ 825,000 ESTIMATED REPLACEMENT VALUE \$3,500,000
CONTRACTOR: Bethlehem Steel Co. IMPROVEMENTS AND COSTS: (1944) Building No. 120, shared with tunnels 2 and 3, Cost \$400,000 per tunnel 1; (1944) Air handling equipment, shared with tunnels 2, 3 and 4, Cost \$750,000 per tunnel 1; (1944-60) Air system improvements, shared with tunnels 2, 3 and 4, Cost \$250,000 per tunnel 2; (1954) Data acquisition system, shared with tunnel 3, Cost \$150,000 per tunnel 1; (1969) Astrodata, shared with tunnels 3 and 4, Cost \$75,000 per tunnel 2; Others, Cost \$25,000.	

PLANS FOR FACILITY IMPROVEMENTS: 1) Tunnel aftercooler to permit higher supply temperatures (shared with tunnel No. 3); 2) Process air precipitron device to remove oil vapors from airstream is installed between Compressor Plant No. 1 and BRL Wind Tunnels Nos. 1 and 3.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	1.25 to 5
Reynolds Number ($\times 10^6/\text{ft}$):	.5 to 8.5
Total Pressure (psia):	3 to 96
Dynamic Pressure (psf):	36 to 1800
Total Temperature ($^{\circ}\text{R}$):	540 to 590
Run Time	Continuous

BRL SUPERSONIC WIND TUNNEL NO. 3

REPORTING INSTALLATION: Ballistics Research Laboratories Exterior Ballistics Laboratory Aberdeen Proving Grounds, Maryland 21005	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Wind Tunnels Branch, Exterior Ballistics Laboratory
OTHER SOURCES OF INFORMATION: Reports: BRL-MR 1292, July 1960; BRL-MR 711, August 1953	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. Robert H. Krieger, Chief, Wind Tunnels Branch Mr. A. S. Platau, Chief, Research Section Phone: (301) 278-4773

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow, variable density supersonic wind tunnel. It is 15 inches wide and either 20 inches or 13 inches high at the test section. The nozzles are formed by upper and lower flexible plates between parallel non-removable sidewalls. The flexible plate adjustment is semi-automatic. Nineteen Mach numbers are calibrated over the range $M = 1.15$ to $M = 4.89$. Typical Mach number uniformity along the centerline of the testing region is $\pm .02$. Flow inclination along the centerline of the testing region is generally within the limits of $0 \pm .3$ degrees over the range of Mach numbers. Supply section screens and contraction fairings are used to minimize turbulence. Air humidity is controlled to specific humidity $< .0002$ for most operating conditions. A variable supersonic diffuser is used in conjunction with replaceable wedge shapes at the downstream test section to provide starting and running flexibility over a variety of configurations at the test section. These configurations extend from completely bare (gun tunnel application), to a model launcher for free-flight models which emerges through a hole in the test section floor during the model launch sequence, to a normal parallelogram slide for sting supported models. Wall mounts, floor mounts, and downstream supported flow survey mechanisms are also selectively used. The compressor plant is the same arrangement as described for BRL Tunnel No. 1. Blowdown, dry make-up air, and high pressure auxiliary air capabilities are also all from the same sources as described for the BRL Tunnel No. 1.

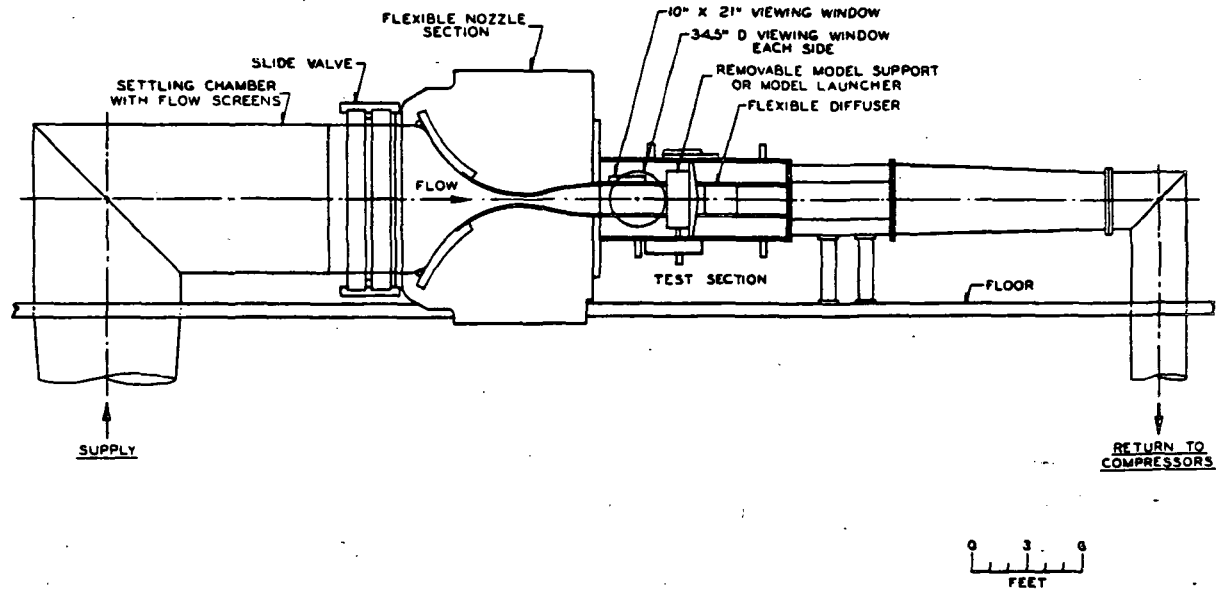
TESTING CAPABILITIES: This facility is capable of: static force and moment, pressure distribution, jet interaction and rocket exhaust, shock wave interaction, free flying models (both Magnus and nonspin), damping in pitch, acoustic projectiles, high speed gun launched projectiles, temperature recovery, flow turbulence and flow surveys (Mach distribution, flow direction, boundary layer) type testing. Models are supported from a double parallelogram slide arrangement which permits model excursions in both angular and linear traverse. Pitch range is normally from -10 to $+15$ degrees. Large test section windows (34-1/2 inch diameter) and parabolic schlieren mirrors (36-inch diameter) permit extensive viewing of models and flow. A third window (9-1/2 inches by 21 inches) in the ceiling of the test section permits orthogonal viewing -- a particular necessity for photographic time vs position data acquisition of the aerodynamic trajectories of free-flying models. The model launcher has the capability of handling models at high rotational velocities for Magnus studies as well as models of the nonspin variety. Gun mounts and projectile catchers are available for high speed projectile firings through the testing region. Data are recorded with an 8-channel Hansen-Corill-Bryan system or a 50-channel Astrodata high speed system and reduced off site on the BRLESC I and BRLESC II systems.

FACILITY COST HISTORY

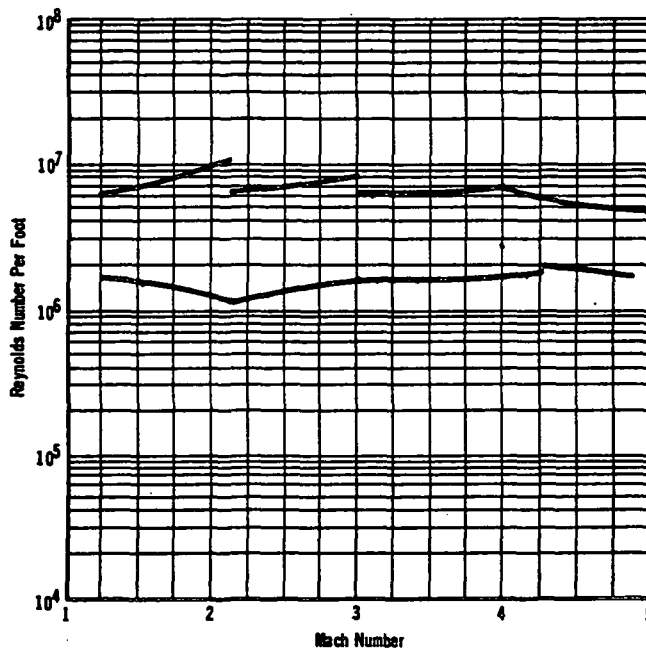
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$5600	CONSTRUCTION YEAR: 1948 COST \$ 800,000 ESTIMATED REPLACEMENT VALUE \$3,500,000
CONTRACTOR: The Baldwin Locomotive Works LOCATION: Philadelphia, Pennsylvania IMPROVEMENTS AND COSTS: (1944) Building No. 120, shared with tunnels 1 and 2, Cost \$400,000 per tunnel (No. 3); (1944) Air handling equipment, shared with tunnels 1, 2 and 4, Cost \$750,000 per tunnel (No. 3); (1948-60) Air system improvements, shared with tunnels 1, 2 and 4, Cost \$250,000 per tunnel (No. 3); (1954) Data acquisition system, shared with tunnel No. 1, Cost \$150,000; (1969) Astrodata system, shared with tunnels 1 and 4, Cost \$75,000; Others, Cost \$125,000.	

PLANS FOR FACILITY IMPROVEMENTS: (1) Tunnel aftercooler to permit higher supply temperatures (shared with Tunnel No. 1); (2) Process air precipitation device to remove oil vapors from airstream. Installed between Compressor Plant No. 1 and BRL Wind Tunnels Nos. 1 and 3.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 1.15 to 4.89
 Reynolds Number ($\times 10^6/\text{ft}$): 1.4 to 9
 Total Pressure (psia): 5.8 to 57.8
 Dynamic Pressure (psf): 140 to 1800
 Total Temperature ($^{\circ}\text{R}$): 540 to 590
 Run Time (seconds): Continuous

BOEING TRANSONIC WIND TUNNEL

REPORTING INSTALLATION: The Boeing Company Commercial Airplane Division P. O. Box 3707 Seattle, Washington 98124	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Commercial Airplane Group
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. W. A. Blissell, Jr. Org G-8340, M.S. 1W-82 Phone: (206) 655-1823

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is a continuous flow, closed circuit, single return facility with an operating range of Mach 0 to Mach 1.2 in an 8 x 12 x 14.5 foot test section which has 12.5 percent wall area in slots. The tunnel stagnation pressure is atmospheric and with a total temperature range of 540°R to 640°R provides a Reynolds number range of 0 to 4×10^6 /ft. A 36,000 hp wound-rotor induction motor in tandem with an 18,000 hp synchronous motor provides the power to drive a 24 foot diameter fan up to a maximum speed of 470 rpm. The fan is made up of an 18 foot diameter hub with 72 fixed pitch Fiberglass blades 36 inches long in two stages which directs circuit air through two stages of 67 hollow steel stators.

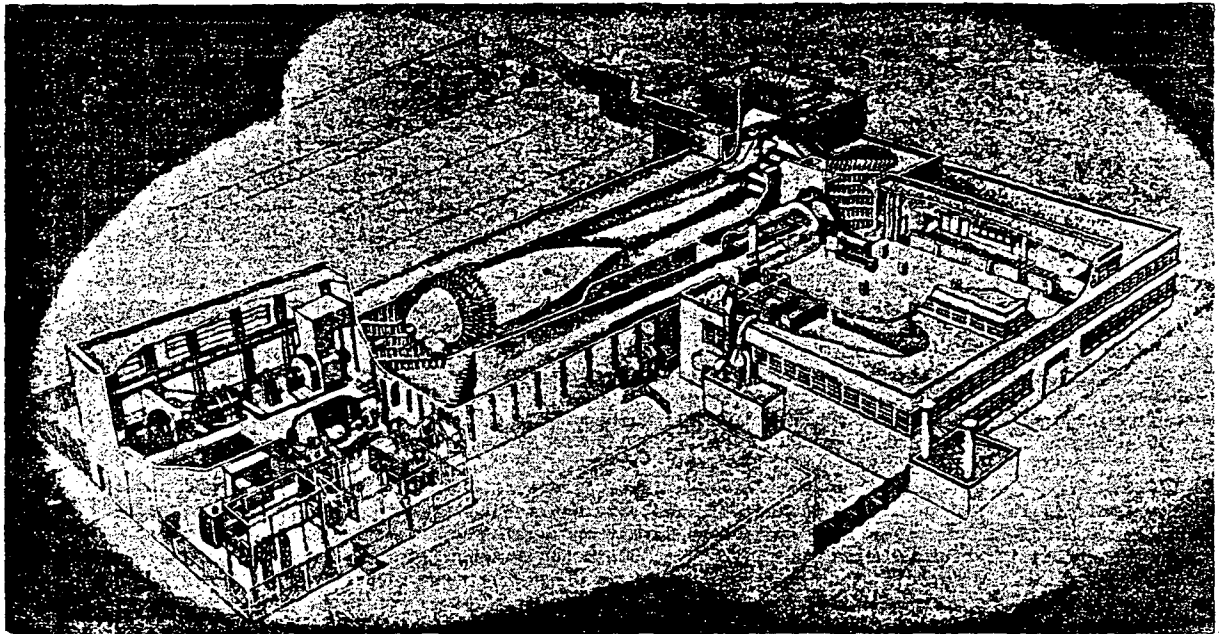
TESTING CAPABILITIES: Models can be mounted in the test section on the floor, wall, floor mounted struts, plate island assembly or on a sting supported by a pitch strut mechanism. A six component external balance is available beneath the test section floor. A complete family of force balances are available for sting or strut mounted models. Auxiliary air is available with a supply pressure of 1000 psia and a flow rate up to 21 lbs/sec at temperatures up to 150 degrees Fahrenheit. If the need arises heated air at a supply pressure of 2600 psia and a flow rate of 17 lbs/sec can be piped into the test section. Also available is an ejector assembly which can provide a weight flow up to 10 lbs/sec. The Boeing Wind Tunnel Data System provides the capabilities of real-time test data acquisition, feedback control computation and display. The data system consists of an Astrodata acquisition subsystem which includes 100 channels with a $\pm 16,000$ count capability and a computing subsystem which uses a Xerox Data System (XDS 9300) digital computer. Test data, which can be sampled up to 256 times per test point, are recorded on a rapid access data drum then final computations are performed and selected on-line displays are provided on analog x-y plotters and teletypewriters. Real-time computations and displays are performed every 200 milliseconds for control and test monitoring functions. Any test data may be retrieved from rapid access drum storage and displayed on an oscilloscope using a light pen for requests.

FACILITY COST HISTORY

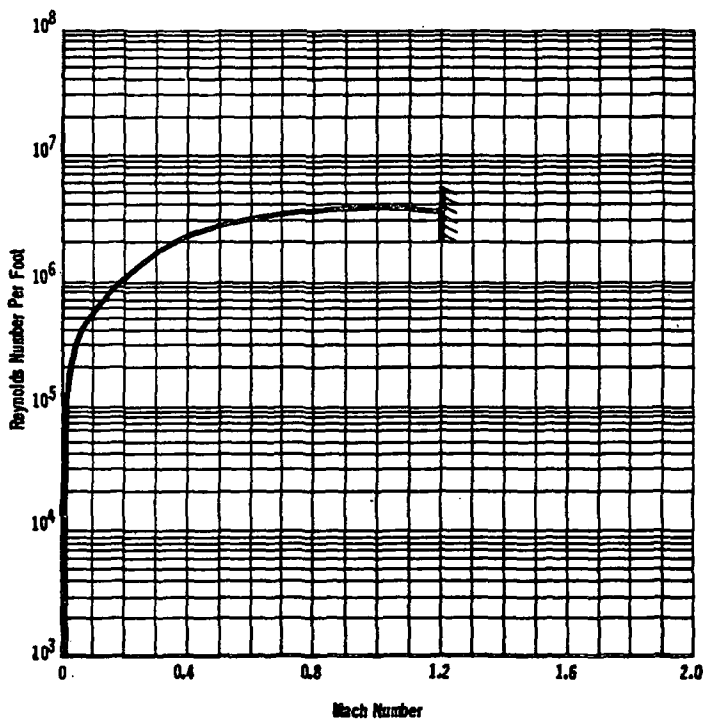
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$7500	CONSTRUCTION YEAR: 1944 COST \$ 750,000 ESTIMATED REPLACEMENT VALUE \$5,044,000
CONTRACTOR: Austin Const. Co. & Westinghouse Elec. Mfg. LOCATION: IMPROVEMENTS AND COSTS: (1953) Modification to transonic tunnel, Cost \$1,750,000; (1955) New instrumentation, Cost \$70,000; (1963) Building air conditioning, Cost \$60,000; (1964) BTWT-Automatic Mach control system, Cost \$26,000; (1964) Model checkout facility, Cost \$120,000; Others including High pressure air supply, Quick-change model installation, XDS 9300 computer, and Astrodata System, Costs \$2,075,000.	

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 0 to 1.2
 Reynolds Number ($\times 10^6/\text{ft}$): 0 to 4
 Total Pressure (psia): Atmospheric
 Dynamic Pressure (psf): 0 to 900
 Total Temperature ($^{\circ}\text{R}$): 540 to 640
 Run Time: Continuous

BOEING 4-FOOT SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION: The Boeing Company Commercial Airplane Division P. O. Box 3707 Seattle, Washington 98124	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Commercial Airplane Group, Aerodynamics Technology Staff
OTHER SOURCES OF INFORMATION: Boeing Document D2-22871, "Test Planning Manual"	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. W. A. Blissell, Jr. Org G-8340, M.S. 1W-82 Phone: (206) 655-1823

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to atmosphere type tunnel with a 4 by 4 by 4 foot test section. The nozzle is equipped with ten hydraulic actuators providing adjustment of the flexible plates which form the sidewalls of the nozzle. The forward edge of each flexible plate is faired into an adjustable circular arc sector which forms the throat of the nozzle for velocities above Mach 2.5. A test section insert is available which provides a 1 ft x 3 ft porous test section with a Mach number range from .2 to 1.3 and a corresponding Reynolds number range of 3 to 7 and 8 to 24 x 10⁶/ft. A 2250 hp compressor provides 12.5 lb/sec air to 55,000 cu ft storage tanks at 145 psia.

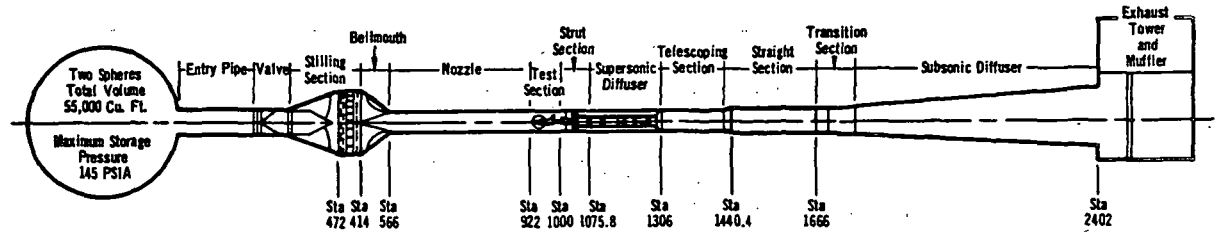
TESTING CAPABILITIES: Tests may be conducted on force, pressure, and flexible models, models with ignited rockets, multiple kerosene burning engines, or engine inlets, and models with instrumented component parts. Models are mounted in one of two ways: on a sting or on a strut attached to the wall or floor. The sting is attached to a vertical strut, 60 inches in chord, which completely spans the tunnel. Two dimensional airfoil models with spans of 1 foot and chords up to 6 inches may be tested. Airfoils may be tested in the cyclic mode up to 96 Hz (helicopter rotor blades) or static mode. In the static mode the airfoil characteristics may be evaluated through force, pressure, wake loss surveys, and oil flow visualization. An auxiliary air pressure supply 20 lb/sec at 1000 psia is available. Data from this facility are acquired and reduced by an Astrodata 50 channel high speed sampled data system and shared XDS 9300 digital computer (on site).

FACILITY COST HISTORY

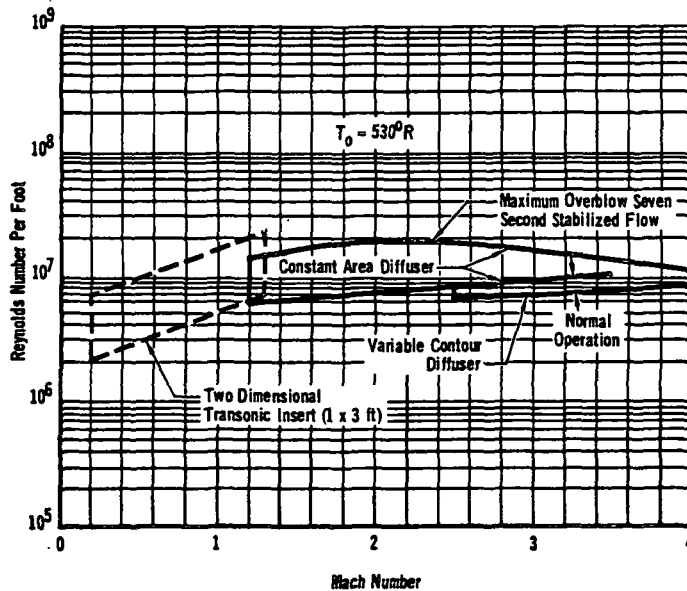
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1957 COST \$2,300,000 ESTIMATED REPLACEMENT VALUE \$4,000,000
CONTRACTOR: H. S. Ferguson Construction; P.D.M. Co. LOCATION: Seattle, Wash.; Pittsburgh, Pa. IMPROVEMENTS AND COSTS: (1960) Proximity plate and actuator, motorized pitch beam block installment 922 stop mechanism, Cost \$15,000; (1962) 2nd throat (var. contour diffuser), Cost \$40,000; (1967) 30 inch schlieren optical system, Cost \$30,000; (1967) Added Honeycomb Flow Straighteners and screens, Cost \$8000; (1967) Dynamic 1/2 model injection system, Cost \$10,000; (1967) Transonic 2-Dimensional test section insert, Cost \$60,000; (1968) Astrodata system, Cost \$225,000; (1968) XDS 9300 computer, Cost \$100,000; Others, Cost \$50,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHMATIC



FACILITY PERFORMANCE DATA



Mach Range:	1.2 to 4
Reynolds Number ($\times 10^6/\text{ft}$):	6 to 17
Total Pressure (psia):	20 to 115
Dynamic Pressure (psf):	1200 to 3200
Total Temperature ($^\circ R$):	525
Run Time (seconds):	7 to 45
Pump Time (minutes):	7 to 45
	Facility Compressor Alone
	2 to 15
	Facility and Auxiliary Compressors

CORNELL 8-FOOT TRANSONIC WIND TUNNEL

REPORTING INSTALLATION: Cornell Aeronautical Laboratory, Incorporated P. O. Box 235 Buffalo, New York 13221	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Transonic Tunnel Department of Cornell Aeronautical Laboratory, Incorporated
OTHER SOURCES OF INFORMATION: Facility Brochure: 8-Foot Transonic Wind Tunnel CAL Report No. WTO-300, March 1968.	LOCAL OFFICE TO CONTACT FOR INFORMATION: John P. Andes, Head, Transonic Tunnel Dept. P. O. Box 235, Buffalo, New York 14221 Phone: (716) 632-7500

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is the result of modifying the 12-foot Variable Density Tunnel (1956). The tunnel is a closed circuit, single return, variable density, continuous flow type tunnel. The modified test section is 8 feet by 8 feet and is of a removable cart type. Sting, reflection plane, fairing, and dynamic stability carts are available. The tunnel has a 22% porous perforated throat with an auxiliary pumping system for plenum pumping. A 16,000 horsepower compressor at 2200 rpm is used for plenum pumping. The compressor is driven by an electric motor rated at 16,000 horsepower at 600 rpm. An auxiliary air supply provides 270,000 standard cubic feet of storage at 2800 psia and can deliver up to 15 lbs/sec airflow.

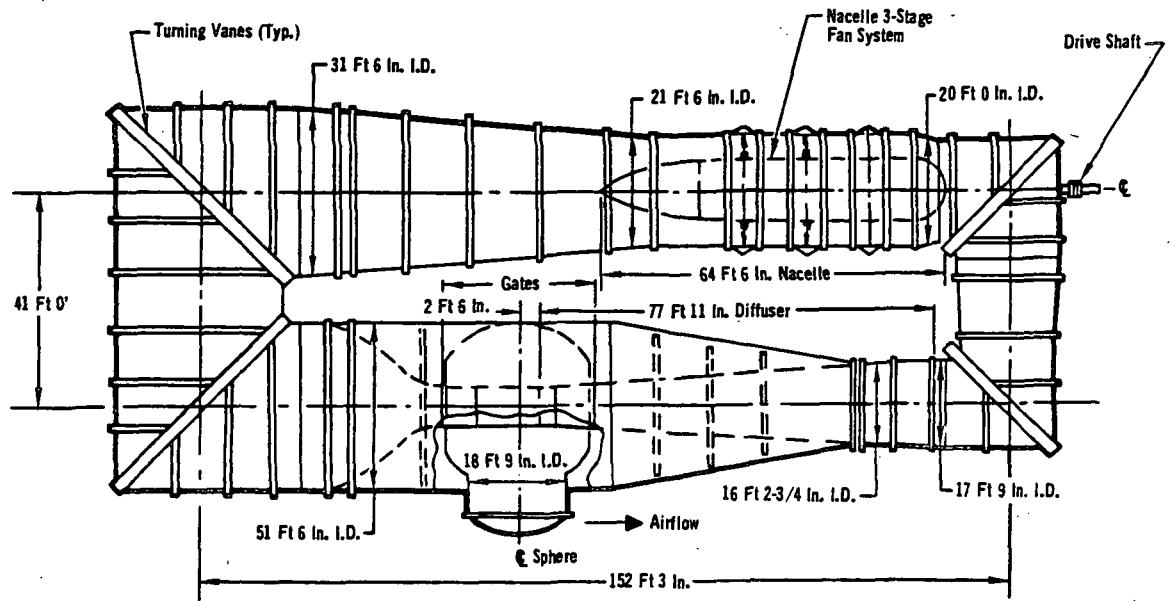
TESTING CAPABILITIES: This tunnel is used for force and moment, pressure, internal duct flow, jet effects (hot or cold), captive trajectory and free drop, rocket test engine, dynamic stability, and flow visualization tests, including use of a shadowgraph or schlieren system. Capabilities also include provisions for tests of half span models and fan engine simulation. The facility's data system provides for 30 channels of data recording. Data are compiled and reduced on the facility's IBM 1800 computer. This facility is capable of three shift operation.

FACILITY COST HISTORY

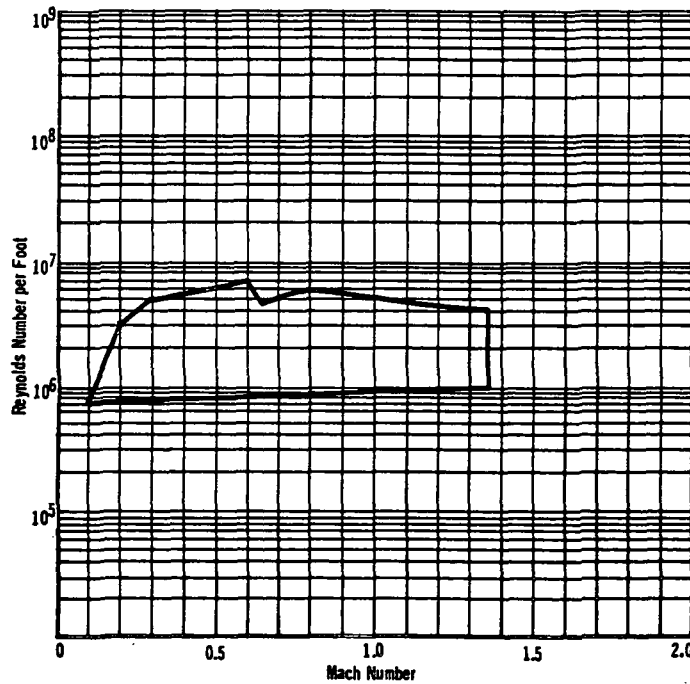
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$6400	CONSTRUCTION YEAR: 1946 COST \$ 4,400,000 ESTIMATED REPLACEMENT VALUE \$25,000,000
CONTRACTOR: Transferred from Curtiss-Wright Corp at time Cornell was founded LOCATION: Buffalo, N.Y. IMPROVEMENTS AND COSTS: (1956) Modernized to 8-foot test section, Cost \$2,270,000; (1965) Repowered auxiliary compressors, Cost \$276,000; (1966) Renovate control room and new cooling towers, Cost \$166,000; (1967) High pressure air compressor - Liquid rheostat air storage, Cost \$537,000; (1968) Replaced Transformer-New Shaft coupling, Cost 232,000; Others, Cost \$330,000.	

PLANS FOR FACILITY IMPROVEMENTS: Extension of Reynolds Number Capability in Subsonic Range - up to 3-1/2 to 4 atm during 1970.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	0 to 1.35
Reynolds Number ($\times 10^6/\text{ft}$):	.7 to 7
Total Pressure (psia):	2.48 to 36.8
Dynamic Pressure (psf):	50 to 800
Total Temperature ($^{\circ}\text{R}$):	560 to 615
Run Time:	Continuous

FLUIDYNE 66-INCH TRANSONIC WIND TUNNEL

REPORTING INSTALLATION: Fluidyne Engineering Corporation 5900 Olson Memorial Highway Minneapolis, Minnesota 55422	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION: Company Booklet	LOCAL OFFICE TO CONTACT FOR INFORMATION: Dr. James S. Holdhusen, Vice President Phone: (612) 544-2721

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This wind tunnel is an atmospheric induction type facility. Ejectors downstream of the test section are operated from a blowdown air storage system, which utilizes a 1600 hp compressor with three stages of compression to produce 515 psia in storage tanks with 10,200 cu ft capacity. The atmospheric air intake is heated with a propane combustion type heater, which can add up to 40,000 Btu/sec, to provide ambient to just above condensation temperatures during normal operations. The test section is 66 inches square with two slotted walls and two solid walls.

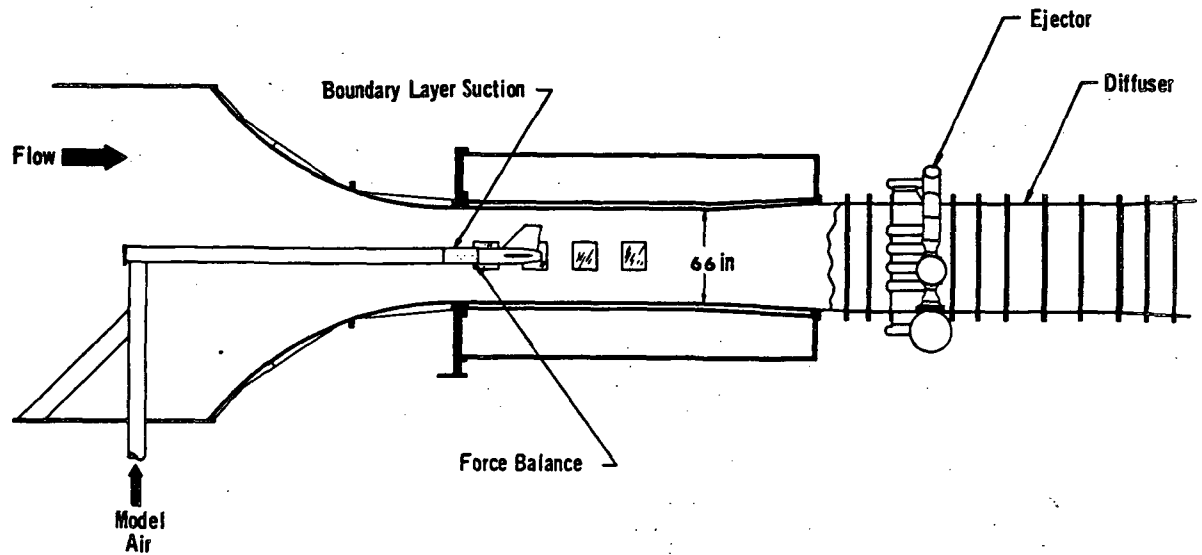
TESTING CAPABILITIES: This tunnel is used for aerodynamic testing of aft fuselage, semispan wing or aircraft, powered nacelle and ram-air turbine models. Single or dual-jet aft fuselage models are mounted from a forward duct which carries the exhaust nozzle(s) flow. Installation thrust-minus-drag is measured. The fuselage boundary layer thickness is variable. Semispan models are mounted from the sidewall to an external multi-component balance. Such tests can also include balances in the semi-span model to measure thrust-minus-drag of the exhaust system and lift and drag on nacelle components. Fixed angle sting, strut and longitudinal support tubes for inlet and nozzle tests are available. Flow visualization is by schlieren and shadowgraph systems. An analog (54 channels) and digital (20 channels) recording system is available along with an on-site time shared data reduction system. This facility is capable of eight runs per shift operation.

FACILITY COST HISTORY

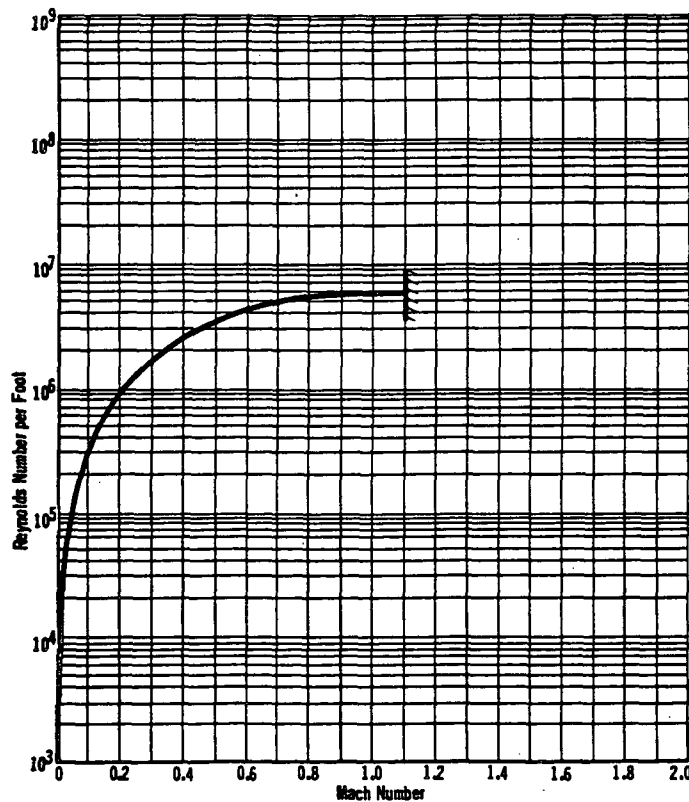
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1969 COST \$1,000,000 ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: Fluidyne Engineering Corporation IMPROVEMENTS AND COSTS:	LOCATION: Medicine Lake Lab

PLANS FOR FACILITY IMPROVEMENTS: Extension of Mach Number to 1.3; Addition of Inlet Force Test Capability

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	0 to 1.0
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 4.7
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 800
Total Temperature ($^{\circ}\text{R}$):	Ambient to just above condensation
Run Time (seconds):	70 at $M = 0.82$

2-17

2-17

GENERAL DYNAMICS 4-FOOT HIGH SPEED WIND TUNNEL

REPORTING INSTALLATION: General Dynamics Corporation Convair Division P.O. Box 1950 San Diego, California 92112	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: General Dynamics Aeromarine Test Facilities
OTHER SOURCES OF INFORMATION: High Speed Wind Tunnel Facility Manual	LOCAL OFFICE TO CONTACT FOR INFORMATION: Department 507-00 Phone: (714) 296-6611, ext 1032

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is an intermittent blowdown to atmosphere type facility capable of transonic and supersonic tests. The tunnel has a flexible nozzle and a variable diffuser. The transonic section replaces the variable diffuser during transonic operation. The test section consists of a plenum tank surrounding the 22% porous walls, a model support, and an ejector section. The ejector system can remove up to 10% of the main tunnel flow; the outflow reenters the main stream downstream of the test section to provide ejector action. Slotted wall inserts, 10% open, are available for subsonic testing. Test section size is reduced to 41.75 inches square. An 8000 hp compressor provides 22 lb/sec air to 28,000 cu ft storage tanks with a maximum pressure of 600 psia.

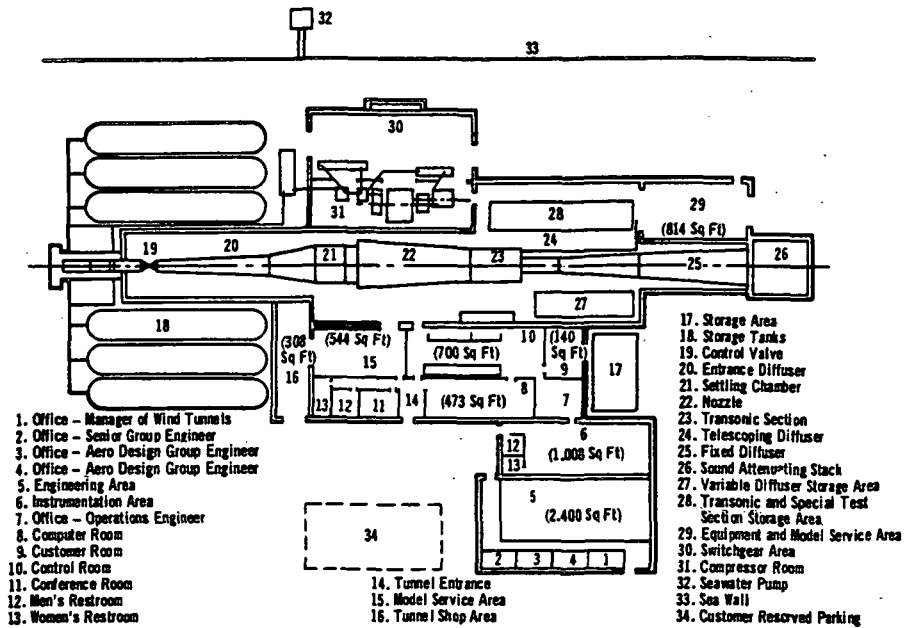
TESTING CAPABILITIES: Force and moment, pressure, heat transfer, and internal duct flow may be tested in this tunnel. Separation testing, both captive trajectory and drop, are also performed. The model support is a single four-element parallelogram type strut. It is mounted in a separate cart which is used with either supersonic or transonic sections. Two sting supports which mount on the model support strut are available. A special insert six feet long can be used for special wall mounted models or when starting loads protection is required. A 24 and an 8 inch schlieren and a shadowgraph system are available. TV monitoring and recording is available. An auxiliary air supply (22 lb/sec up to 300 psia) is available. A 140 channel data recording system and an on site IBM 1800 computer are used.

FACILITY COST HISTORY

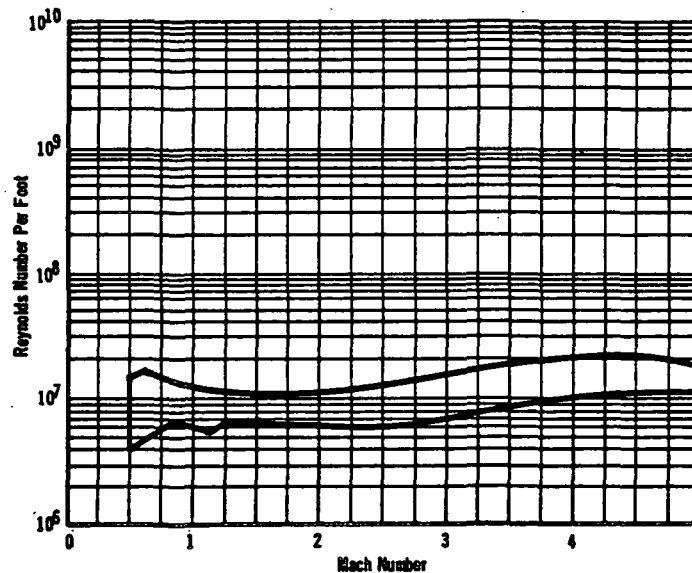
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$3280 + Direct Labor (See Note)	CONSTRUCTION YEAR: 1958 COST \$3,500,000 ESTIMATED REPLACEMENT VALUE \$6,000,000
CONTRACTOR: Chicago Bridge and Iron	LOCATION: Oak Brook, Illinois
IMPROVEMENTS AND COSTS: (1960) Roll sting, Cost \$36,000; (1964) Nozzle test rig, Cost \$35,000; (1964) Special Test section, Cost \$85,000; (1965) Captive trajectory, Cost \$63,000; (1966) Vector thrust stand, Cost \$25,000	
NOTE: Direct labor costs vary widely with test requirements and hourly wage rates are steadily increasing.	

PLANS FOR FACILITY IMPROVEMENTS: Ejector system to permit low RN capabilities will be installed in June 1970 at a cost of \$270,000.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.5 to 5.0
Reynolds Number ($\times 10^6/\text{ft}$):	5 to 23*
Total Pressure (psia):	22.5 to 330
Dynamic Pressure (psf):	1000 to 2500*
Total Temperature ($^{\circ}\text{R}$):	560
Run Time (seconds):	45 to 90
Pump Time (minutes):	30

*Higher values obtainable under certain conditions

GRUMMAN 15-INCH SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Grumman Aerospace Corporation Plant Number 5 Bethpage, L.I., New York 11714	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Test Section
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (516) 575-7044

DESCRIPTION AND TESTING CAPABILITY

FACILITY DESCRIPTION: This is an intermittent blowdown to atmosphere facility with a 15 by 15 by 18 inch test section. The tunnel makes use of fixed nozzle blocks covering a Mach number range of 1.5 to 4.0. An alumina type air dryer is used to dry the air to a dewpoint of 0-10 degrees Fahrenheit at 3000 psi. This facility has an 1189 cu ft air storage at 3000 psia, which provides the tunnel airflow.

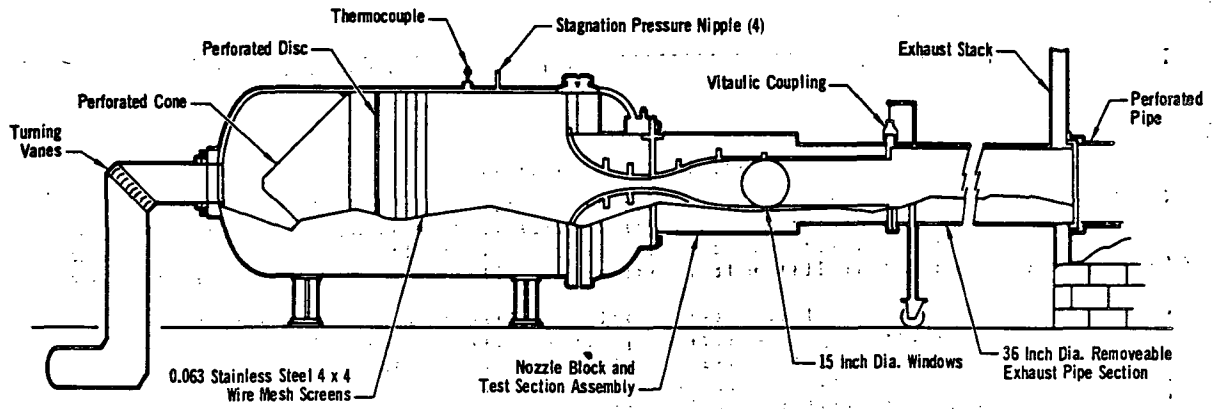
TESTING CAPABILITIES: This tunnel has a sector, which provides an angle of attack range of ± 15 degrees, and a four and a six-component internal strain gage force balance for measuring static aerodynamic forces. A pogo stick type of support raises from the floor to restrain sting mounted models during starting and stopping transients. A 30 lbs/sec at 1000 psid auxiliary air supply is available. Schlieren and shadowgraph are utilized air flow visualization. Data are recorded using 100 channels and reduced on site with the System Engineering Laboratories 810A Computer System.

FACILITY COST HISTORY

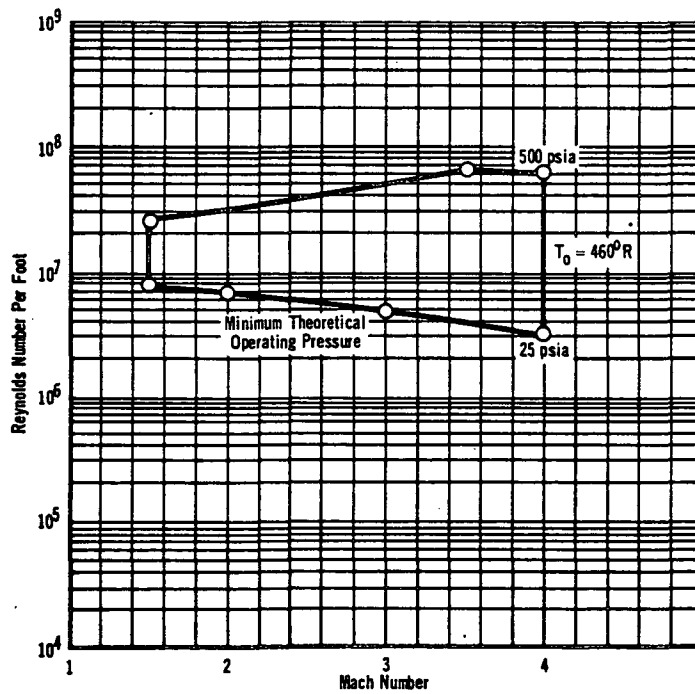
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2000	CONSTRUCTION YEAR: 1958 COST \$ 715,000 ESTIMATED REPLACEMENT VALUE \$1,000,000
CONTRACTOR: Wind Tunnel Instrument Co.	LOCATION: Newton, Massachusetts
IMPROVEMENTS AND COSTS: (1968) Control console; (1968) Air valve control system; (1968) Data Acquisition System; (1968) Quick open working section windows.	

PLANS FOR FACILITY IMPROVEMENTS: An exhaust nozzle test rig is now under construction. A wall balance for reflection plane tests is also under construction. Further plans include an ejector assist for reduced starting loads, a roll mechanism and a variable speed pitch drive.

SCHMATIC



FACILITY PERFORMANCE DATA



Mach Range:	1.5, 1.75, 2, 2.5, 3, 3.5, 4
Reynolds Number ($\times 10^6/\text{ft}$):	8.5 to 65
Total Pressure (psia):	50 to 500
Dynamic Pressure (psf):	1550 to 6700
Total Temperature ($^\circ R$):	460
Run Time (seconds):	40 to 180
Pump Time (lb/hour):	700

GRUMMAN 26-INCH TRANSONIC WIND TUNNEL

REPORTING INSTALLATION: Grumman Aerospace Corporation Plant 5 Bethpage, L.I., New York 11714	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Test Section, Department 400
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Tunnel is physically located at Farmingdale, New York Phone: (516) 575-7044

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is an intermittent blowdown to atmosphere type facility. The 26 inch octagonal test section is 30 inches long and is ten percent slotted to permit transonic operation. The Mach number is controlled by use of a sliding gate valve downstream of the section. This facility has a 1189 cu ft storage tank which holds air at pressures up to 3000 psia for running the tunnel.

TESTING CAPABILITIES: This tunnel was intended primarily for flutter tests, although it is also suitable for general aerodynamic testing. Model mounting consists of variable angle sting and strut type mounts, with a one degree per second to ten degrees per second pitch rate. An auxiliary air supply (30 lb/sec at 1000 psid) is available. Schlieren and shadowgraph systems are available for flow visualization purposes. Data are recorded on a 100 channel recording system, SEL 810A, and reduced on site with the SEL 810 system.

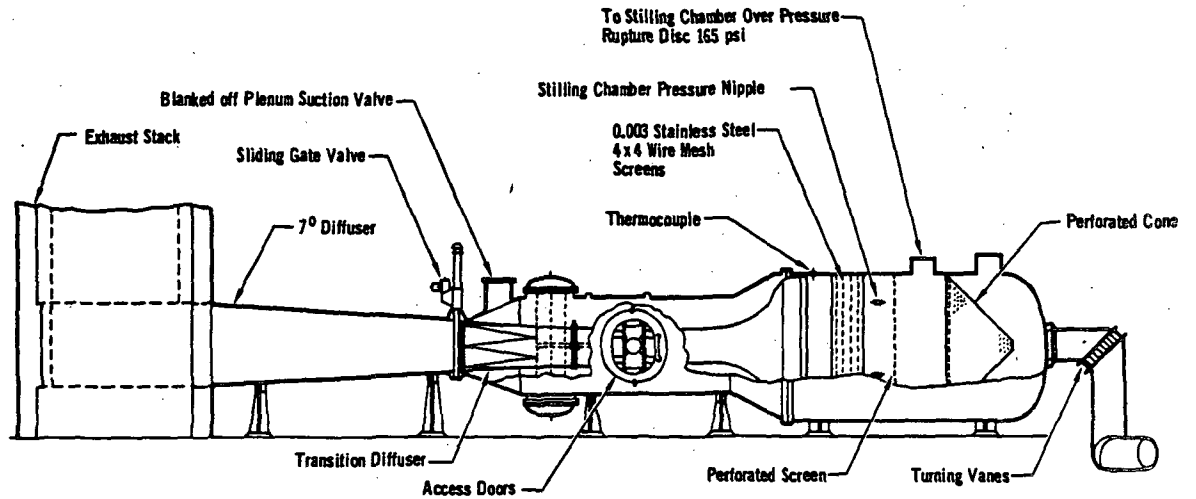
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2000	CONSTRUCTION YEAR: 1958 COST \$ 700,000 ESTIMATED REPLACEMENT VALUE \$1,500,000
CONTRACTOR: Wind Tunnel Instrument Company IMPROVEMENTS AND COSTS: (1968) Control console, Cost (see Note); (1968) Main air valve control system, Cost (see Note); (1968) Data acquisition system, Cost (see Note); (1968) Sting mount pitch mechanism, Cost (see Note); (1969) Quick open manway to plenum, Cost (see Note); (1969) Hinged sidewall in work section, Cost (see Note).	LOCATION: Newton, Massachusetts

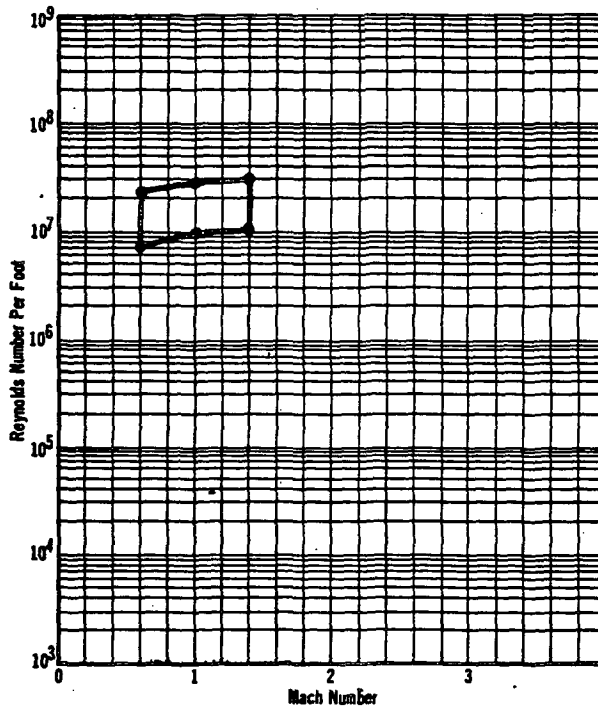
NOTE: Total Improvements (1968-69). Cost \$750,000.

PLANS FOR FACILITY IMPROVEMENTS: (1970) An exhaust nozzle test rig is now under development. A wall balance for reflection plane tests is under construction.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.6 to 1.3
Reynolds Number ($\times 10^6/\text{ft}$):	7 to 29
Total Pressure (psia):	25 to 75
Dynamic Pressure (psf):	835 to 4600
Total Temperature ($^{\circ}\text{R}$):	460
Run Time (seconds):	20 to 40
Pump Time (minutes):	Not Available

LOCKHEED-CALIFORNIA 4-FOOT TRISONIC WIND TUNNEL

REPORTING INSTALLATION: Lockheed-California Company P. O. Box 551 Burbank, California 91503	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION: Lockheed Brochure, Report Number C-1-II	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (213) 847-6121, ext 131

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to atmosphere type tunnel with a 4-foot by 4-foot test section. The tunnel is equipped with a flexible nozzle operated by hydraulically controlled jacks. An extension cart is available to accommodate unusually long models. A variable diffuser has moving sidewalls to provide an adjustable "second throat" to give optimum running efficiency. Air is supplied to storage tanks of 50,000 cubic feet volume at temperatures in the range 100°F to 250°F. The normal pressure level in storage is 600 psia. The compressors used are two centrifugal machines in series on a single shaft driven by a 7000 hp synchronous motor.

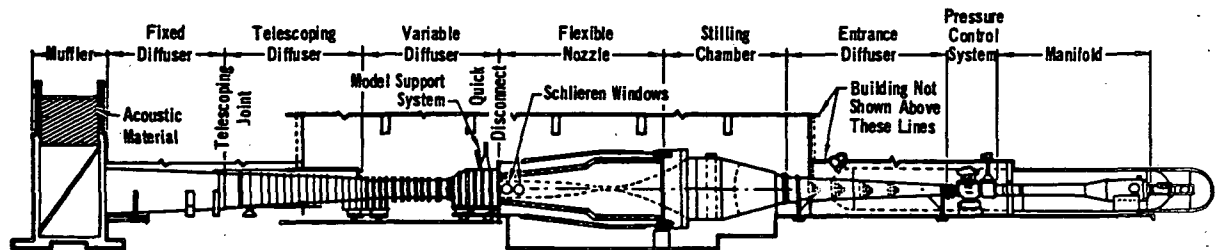
TESTING CAPABILITIES: A through-strut type model support is mounted in the upstream end of the variable diffuser section. The support system is electro-hydraulically operated and provides great flexibility in all modes of operation. The normal pitch range for straight stings is from -15 degrees to +25 degrees. Automatic or manual control is available. A roll mechanism may be attached to the normal pod to provide controlled rotation over the complete roll range. The data system installed is a high speed system capable of scan rates of 7000 samples per second. A total capacity of 52 low level channels is provided. The input signals may be from strain gages, pressure transducers, or thermocouples. A pressure sensing package is available. Data are reduced on an SDS 930 computer system.

FACILITY COST HISTORY

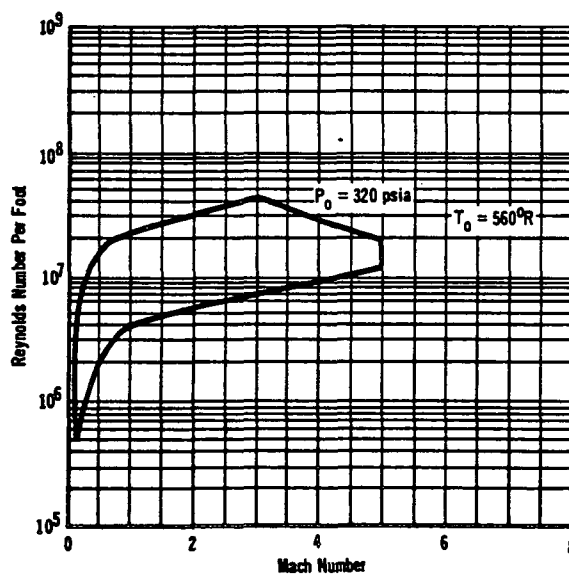
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ Not Available ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.1 to 5
Reynolds Number ($\times 10^6/\text{ft}$):	1 to 43
Total Pressure (psia):	20 to 320
Dynamic Pressure (psf):	1150 to 5000
Total Temperature ($^\circ\text{R}$):	570 to 660
Run Time (seconds):	7 to 100

LOCKHEED-GEORGIA TRISONIC WIND TUNNEL

REPORTING INSTALLATION: Lockheed-Georgia Company Marietta, Georgia 30060	STATUS OF FACILITY: Initial Activation COGNIZANT ORGANIZATIONAL COMPONENT: Lockheed-Georgia Research Laboratory, Department 72-14, Zone -403
OTHER SOURCES OF INFORMATION: "Lockheed-Georgia Company Quarterly", Winter 1969-1970	LOCAL OFFICE TO CONTACT FOR INFORMATION: Associate Director, Aerospace Sciences, Department 72-14, Zone -403 Phone: (404) 424-4480

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a blowdown to atmosphere type transonic wind tunnel. The test section is 20 by 28 by 72 inches with variable porosity walls. Initial operation will be in the transonic range ($M = 0.3$ to 1.3) with future operation up to a Mach number of 4.5 . Design emphasis was placed on the production of a high quality, high Reynolds number flow. The tunnel has been designed for a stagnation pressure of 175 psia in the transonic range (250 psia for the supersonic range) which results in unit Reynolds numbers from 40×10^6 at $M = 0.5$ to 60×10^6 at $M = 1.3$. The stagnation pressure is controlled to within ± 0.3 percent by a sleeve-type regulating valve. An expansion joint downstream of the regulating valve isolates the test section from the mechanical vibrations of the valve. A flow conditioning system consisting of an acoustical silencer and a combination of screens and honeycomb is provided to reduce acoustical and vorticity-generated turbulence in the test section. The test section has an aspect ratio of approximately $.7$ which allows optimum testing of two-dimensional and three-dimensional wing models, and retains the capability for testing complete aircraft models which must satisfy both blockage and span-to-width-ratio requirements.

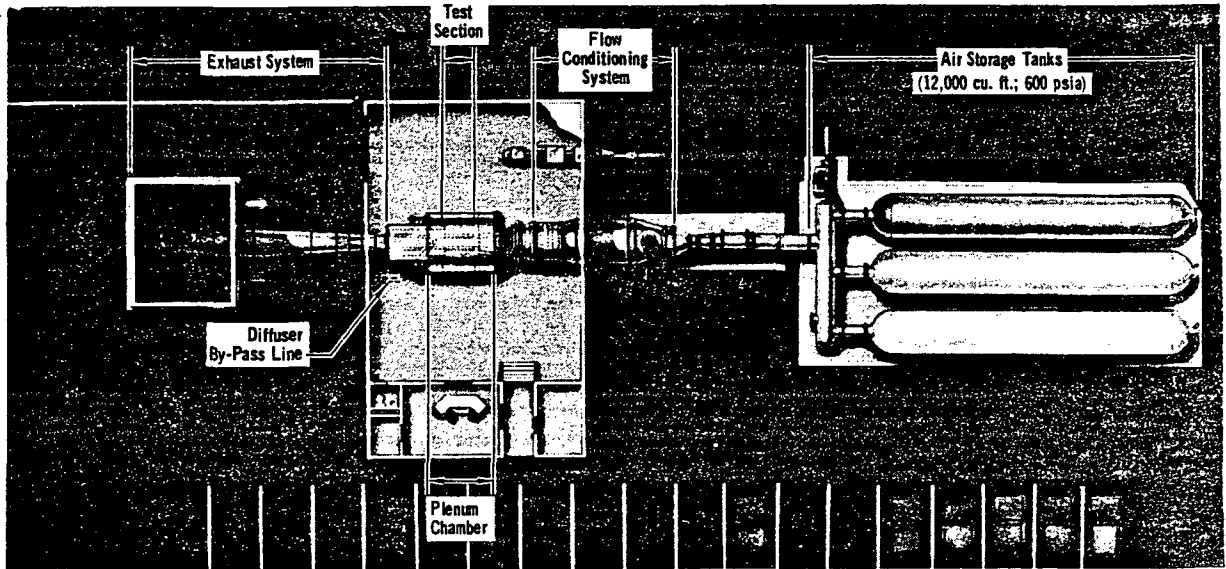
TESTING CAPABILITIES: Model mounting provisions include two-dimensional (side wall to side wall) and three-dimensional (bottom wall) systems. Capability for a future sting model mount system is retained in the design. A variable diffuser and plenum bleed system will be used to control Mach number in the subsonic-transonic range. A fixed diffuser connects the variable diffuser to an exhaust stack containing sound attenuating material. Data are recorded using 256 channels and reduced off site.

FACILITY COST HISTORY

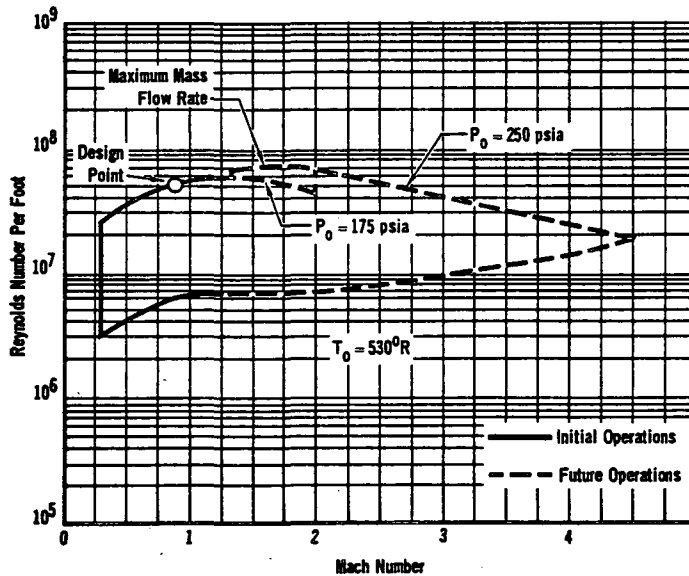
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1968-70 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: Pittsburgh-Des Moines Steel Co. IMPROVEMENTS AND COSTS: (Not Available)	LOCATION: Neville Island, Pittsburgh, Pa.

PLANS FOR FACILITY IMPROVEMENTS: Sting Support, Supersonic Nozzle Blocks, Increased Air Storage Capability, Expanded Data Acquisition System.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.3 to 1.3
Reynolds Number ($\times 10^6/\text{ft}$):	3 to 60
Total Pressure (psia):	20 to 250
Dynamic Pressure (psf):	Not available
Total Temperature ($^\circ R$):	Ambient
Run Time (seconds):	7 to 140

LTV VAD HIGH SPEED WIND TUNNEL

REPORTING INSTALLATION: LTV Aerospace Corporation P.O. Box 5907 Dallas, Texas 75222	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Vought Aeronautics Division
OTHER SOURCES OF INFORMATION: Facility Handbook, Publication AER-EIR-135552-13	LOCAL OFFICE TO CONTACT FOR INFORMATION: Gas Dynamics Laboratories Phone: (214) 266-2751

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to atmosphere type tunnel. The test section is 4 feet by 4 feet by 5 feet. The transonic section is removable and has a normal hole-perforated wall with 22.5 percent porosity. Transonic Mach number control is maintained by servo controlled choking flaps and ejector flaps located downstream of the test section. The tunnel is equipped with a variable flexible nozzle, eleven turbulence screens in the stilling chamber, cooling tower, and air dryer system. An 8000 hp main drive provides 18 lb/sec air to provide 600 psia in storage tanks with a 28,000 cu ft capacity.

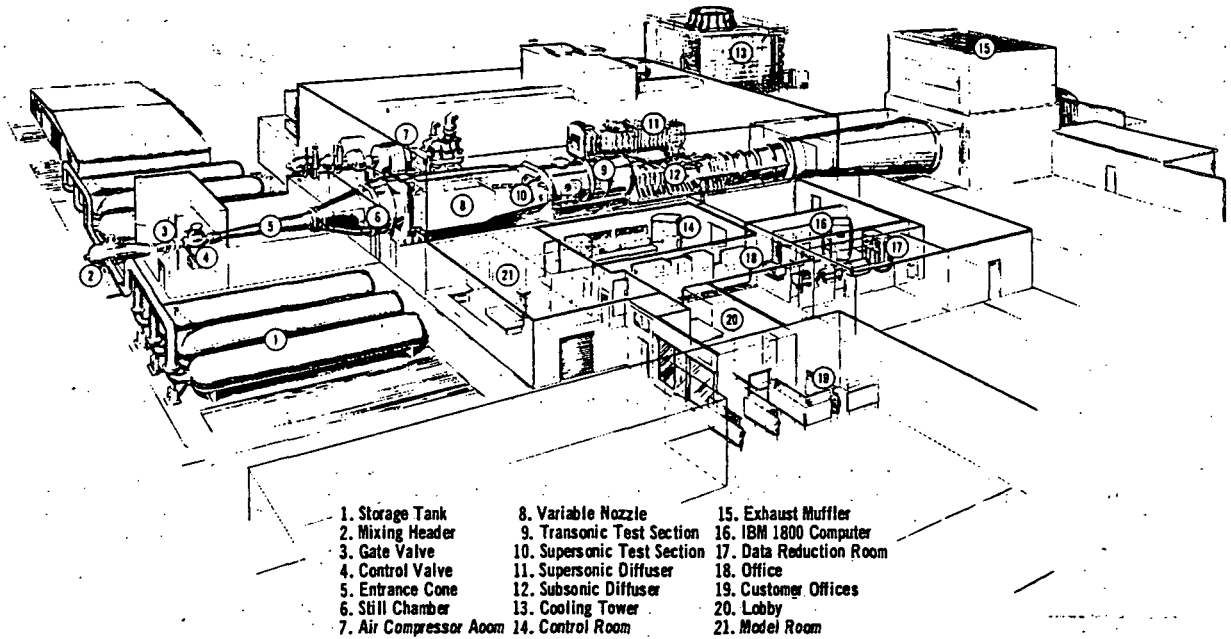
TESTING CAPABILITIES: The tunnel is used for force and moment, pressure, heat transfer, internal duct flow, flutter, dynamic stability, jet effects (hot and cold), and digital computer controlled captive trajectory tests. Numerous sting and balance configurations are available to accommodate testing over a wide range of conditions. The tunnel is capable of holding Reynolds number precisely constant by varying the stagnation pressure as a function of temperature. An exhaust system test capability is operational. This facility has a 400 psi, 16 lb/sec and a 200 psi, 32 lb/sec auxiliary air pressure supply system. Schlieren and shadowgraph systems are available for flow visualization. Data are recorded on a Beckman Amplexer Signal Conditioning IBM 1800 (80 channels) system. An IBM 1800 computer is on site for data reduction purposes.

FACILITY COST HISTORY

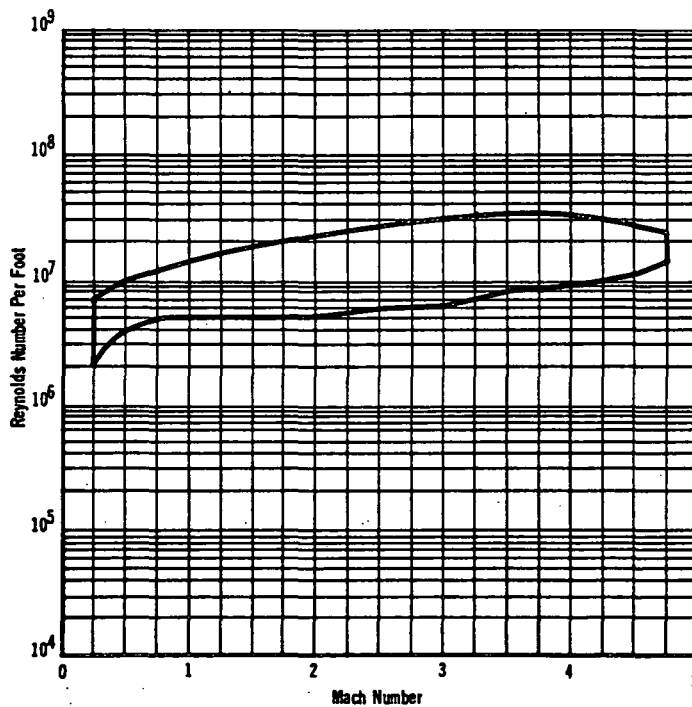
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$4500	CONSTRUCTION YEAR: 1956-58 COST \$3,830,000 ESTIMATED REPLACEMENT VALUE \$Unknown
CONTRACTOR: Chicago Bridge and Iron	LOCATION: Chicago, Illinois
IMPROVEMENTS AND COSTS: (1962) Building addition, Cost \$60,000.	

PLANS FOR FACILITY IMPROVEMENTS: Modification to section between control valve and settling chamber planned for 1970, to reduce turbulence and improve flow quality.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.2 to 5
Reynolds Number ($\times 10^6/\text{ft}$):	2 to 38
Total Pressure (psia):	20 to 350
Dynamic Pressure (psf):	150 to 5000
Total Temperature ($^{\circ}\text{R}$):	560
Run Time (sec):	40 to 120
Pump Time (minutes):	30 to 45

MCDONNELL DOUGLAS 4-FOOT TRISONIC WIND TUNNEL

REPORTING INSTALLATION: McDonnell Douglas Corporation McDonnell Douglas Astronautics 3000 Ocean Park Blvd. Santa Monica, California 90406	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Engineering Laboratories
OTHER SOURCES OF INFORMATION: The Douglas Aerophysics Laboratory 4-Foot Trisonic Wind Tunnel, Douglas Report DAC-59809, October 1967	LOCAL OFFICE TO CONTACT FOR INFORMATION: Douglas Aerophysics Laboratory El Segundo, California Phone: (213) 322-1140

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The Douglas Trisonic Tunnel is an intermittent blowdown to atmosphere type tunnel. Two test sections are available. One is a 4 foot by 4 foot by 17 foot transonic perforated test section with 22 percent porosity. The other test section (which consists of the last 5 feet of the nozzle) is a 4 foot by 4 foot supersonic test section. The nozzle consists of adjustable flexible top and bottom plates and can be varied to obtain any Mach number between .2 to 5.0. The diffuser section of the tunnel is composed of two sections, a variable geometry second throat and a fixed geometry downstream section. The downstream section of the diffuser contains the air-driven ejector system which is used primarily to reduce loads imposed upon the model during the tunnel starting and stopping processes. The entire diffuser can be moved to open the downstream end of the test sections. The 4-foot square test section provides for the development testing of large models, closely simulating full scale flight conditions. The main drive compressors (13,500 hp) provide 42 lb/sec air to produce 525 psia air in the 34,000 cu ft air storage supply tanks.

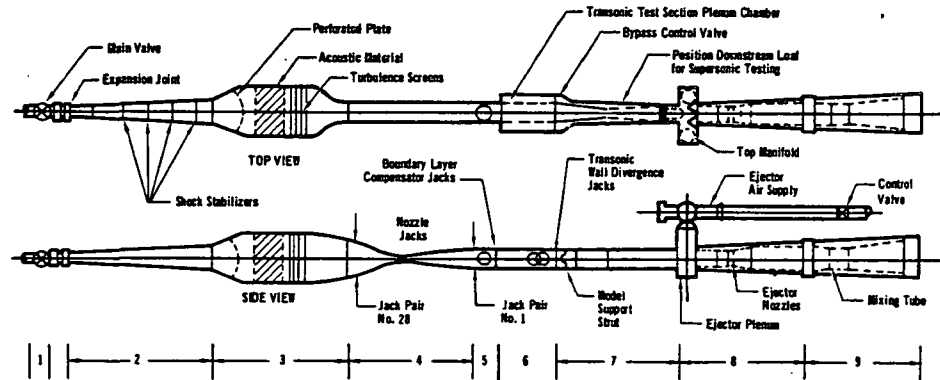
TESTING CAPABILITIES: This tunnel is used for force and moment, pressure, heat transfer, internal duct flow, rocket effects (hot or cold), and panel flutter tests. Model mounting consists of sting and strut type support. The thick (up to 6 inches), turbulent boundary layer on the sidewalls of the test section is used for studies involving the interaction of a boundary layer with compression corners, shock wave perturbances, wall-jets, etc., at Reynolds number, based on effective model length, in the range $10^8 \leq Re_x \leq 10^9$. Model pitch attitude is controlled through either a pitch-pause mode of operation (maximum of 16 pre-set angles) or a pitch-sweep mode of operation (sweep rate adjustable in the range 0 to 12 degrees per second). A remote roll mechanism is available to control roll attitude. An auxiliary high pressure air supply of .01 to 50.0 lbs/sec at 40 to 3000 psia air is available. Schlieren, shadowgraph, china clay, liquid crystal, and oil flow are used for flow visualization. Data are recorded using 32 channels (192 multiblock mode) and reduced with a Xerox Data Systems (XDS) 930 computer on site. Data tabulations and plots are available within a few minutes of the completion of a run. The average run rate for the facility is 21 runs per 8 hour day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$6000	CONSTRUCTION YEAR: 1959 COST \$4,500,000 ESTIMATED REPLACEMENT VALUE \$7,000,000
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: (1962) Transonic cart, Cost \$200,000; (1964) Protective shoes, Cost \$30,000; (1966) Air ejectors, Cost \$350,000; (1969) Remote roll motor, Cost \$10,000; Others, Cost \$120,000.	

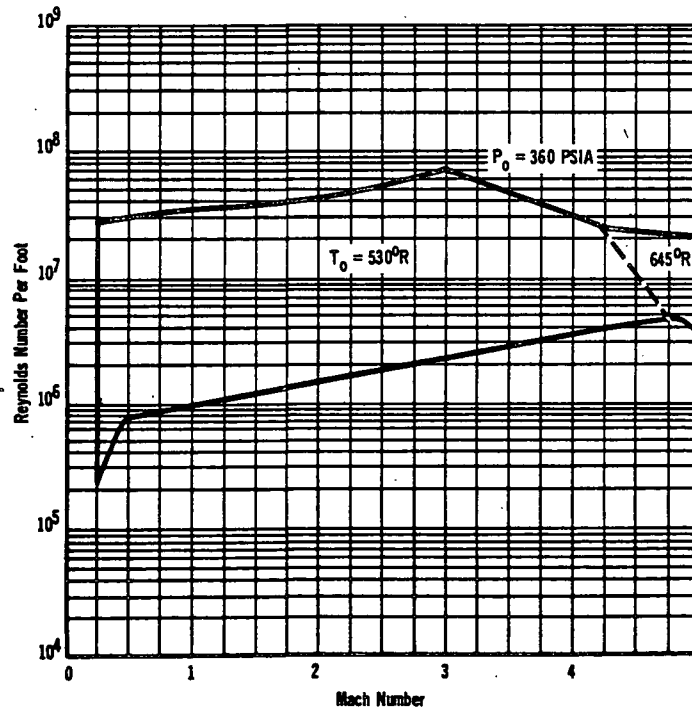
PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



- 1 CONTROL VALVE Valve regulated during run by electro-mechanical controller to maintain constant pressure in stilling chamber.
- 2 ENTRY DIFFUSER Entrance cone, 6° included angle; 4 shock stabilizer rings.
- 3 STILLING CHAMBER Dished, 30% open-perforated plate; acoustic panels for 15-20 db acoustic energy attenuation; 4 turbulence screens.
- 4 NOZZLE 2-0.76" thick flexible plates, each controlled by 28 jacks; Contours for Mach 1.0 to 5.0.
- 5 SUPersonic TEST SECTION 60" long; 30" dia windows in sidewalls; 24" openings top and bottom; boundary layer compensation.
- 6 TRANSONIC TEST SECTION 144" long; 30" dia windows at one of two positions; 4 walls perforated, 22% open, holes normal to wall. Adjustable divergence on top and bottom walls, $\pm 0.25^\circ$ to -2° . Section removable and downstream circuit moves up.
- 7 MODEL SUPPORT, BYPASS CONTROL VALVE & VARIABLE DIFFUSER Full height vertical strut with vertical motion and -15° to $+25^\circ$ pitch capability, 8" maximum strut width. Bypass valve controls Mach number. Downstream leaf of variable diffuser disconnected from upstream leaf for transonic testing. Variable throat allows extended run times at supersonic Mach numbers.
- 8 TELESCOPING DIFFUSER Telescopes into fixed diffuser, opening tunnel for model installation and changes. Also, houses 4 conical ejector nozzles and constant section of mixing tube.
- 9 FIXED DIFFUSER AND MIXING TUBE Convergent divergent tube mixes ejector and main airflows and completes expansion to muffler tower.

FACILITY PERFORMANCE DATA



Mach Range:	.2 to 5.0
Reynolds Number ($\times 10^6/\text{ft}$):	.25 to 60
Total Pressure (psia):	10 to 360
Dynamic Pressure (psf):	200 to 3800
Total Temperature ($^\circ\text{R}$):	520 to 685
Available Run Time (sec):	5 to 110
Recycle Time (minutes):	15

MCDONNELL DOUGLAS POLYSONIC WIND TUNNEL

REPORTING INSTALLATION: McDonnell Douglas Corporation McDonnell Aircraft Company P.O. Box 516 St. Louis, Missouri 63166	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: General Engineering Division Gas Dynamics Laboratory (Dept. 254)
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Gas Dynamics Laboratory, McDonnell Aircraft Co. Phone: (314) 232-5331

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The McDonnell Polysonic Wind Tunnel (PSWT) is an intermittent blowdown to atmosphere type facility used for transonic and supersonic testing. A flexible plate nozzle is used to generate flow in the 4-foot by 4-foot supersonic test section. For transonic testing, a removable cart is installed between the downstream end of the flexible nozzle and the movable diffuser. The cart provides a 4-foot by 4-foot by 9-foot long transonic test section with 25 percent porous, perforated walls. Transonic Mach number control is provided by automatic by-pass valves which maintain a constant Mach number throughout the model pitch range. An ejector system is provided in the diffuser to permit quick tunnel starting at all Mach numbers. The tunnel and ejector air is stored in six storage tanks (capacity 40,000 cu ft) at 625 psia. A thermal storage mass helps provide relatively constant stagnation temperature throughout the run and a propane fired air heater is used at high Mach numbers to prevent water condensation. The six storage tanks are supplied with air from compressors having a 7000 hp main drive and 10 stages of compression providing 20 lb/sec to pressurize the tanks to 625 psia.

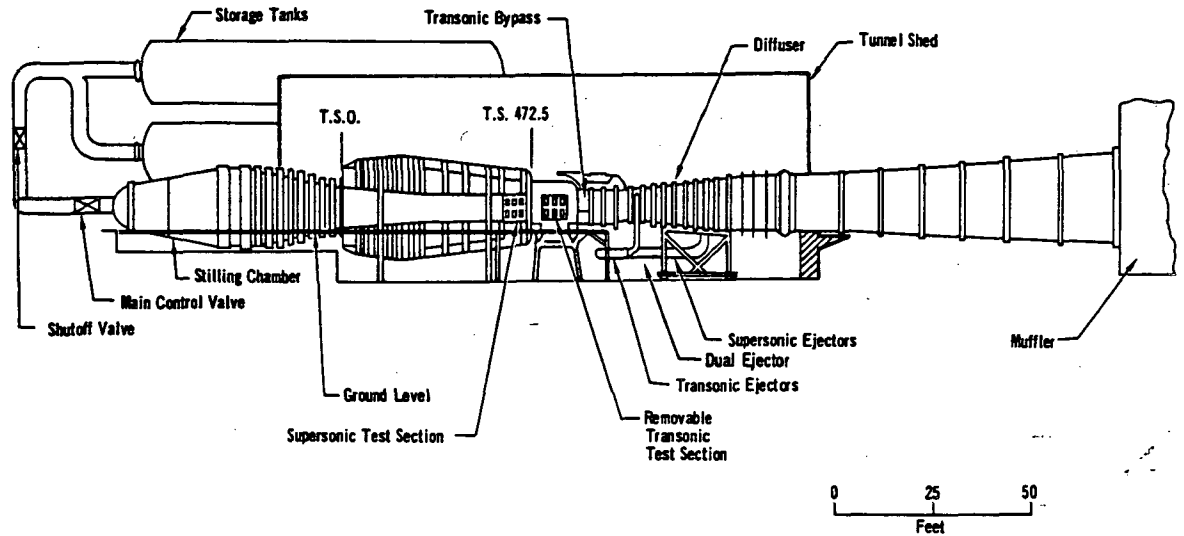
TESTING CAPABILITIES: This tunnel is used for force and moment, pressure, internal duct flow, jet effects (cold), panel flutter, and capsule ejection tests. The model is supported from a sector-type mount. Schlieren and shadowgraph systems are available along with oil-flow, tuft-study, and photographic coverage. The control room is equipped with a television monitoring system for model visualization during a run. Data are recorded on a C.E.C. Micro-Sadic with 125 channels and reduced on an IBM 360/25 on-site and an IBM 360/85 off-site computer system. This facility is capable of three shift operation.

FACILITY COST HISTORY

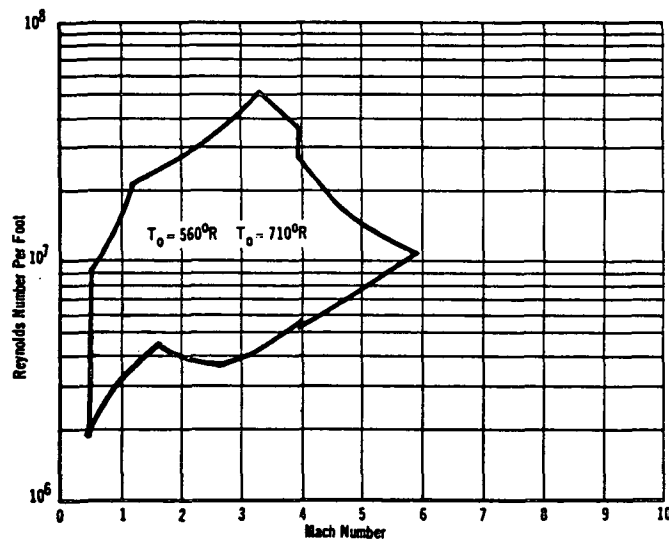
AVERAGE ESTIMATED OPERATING \$6400	CONSTRUCTION YEAR: 1959	COST \$4,288,000
COST (TYPICAL 8 HOUR SHIFT): Government \$2000	ESTIMATED REPLACEMENT VALUE \$7,000,000	
CONTRACTOR: Nooter Corp.	DESIGN: Sverdrup & Parcel	LOCATION: St. Louis, Missouri (Both)
IMPROVEMENTS AND COSTS: (1961) Provide screens and grids in stilling chamber, Cost \$35,000 (est); (1962) Transonic bypass, Supersonic ejectors, Diffuser modification, Cost total \$294,000; (1962) Honeycomb, Porous wall, Cost \$50,000; (1967-68) 600 psig auxiliary air supply, Cost \$30,000; (1969) Dual ejectors, Cost \$25,000; Others include Compressor, Piping, Operational and Data System improvements and Cost \$158,000.		

PLANS FOR FACILITY IMPROVEMENTS: Arc Sector Improvements (remote roll); Schlieren Improvements; New On-Site Computer; Additional Air Tanks; New 600 psig Compressor; 250 Channel Data System

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.5 to 5.8
Reynolds Number ($\times 10^6/\text{ft}$):	2 to 50
Total Pressure (psia):	10 to 400
Dynamic Pressure (psf):	250 to 6500
Total Temperature ($^\circ R$):	530 to 710
Run Time (Seconds):	30 (Average)
Pump Time (Minutes):	30

NASA AMES 11-FOOT TRANSONIC WIND TUNNEL (UNITARY)

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-227-5 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Assistant Director for Aeronautics and Flight Aeronautics Division Experimental Investigations Branch
OTHER SOURCES OF INFORMATION: Vol II, ARC Research Facilities Summary	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Experimental Investigations Branch Mail Stop N-227-5 Phone: (415) 961-1111, ext 2746

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is the transonic leg of the Ames Unitary facility. It is a closed circuit, single return, continuous flow, variable-density tunnel. The 11 by 11 by 22 foot test section is slotted to permit transonic testing. The nozzle has adjustable sidewalls. The tunnel air is driven by a 3-stage axial flow compressor powered by four wound-rotor induction motors. The speed of the motors is varied as necessary to provide the desired Mach number. The motors have a combined output of 180,000 horsepower for continuous operation or 216,000 horsepower for one hour. Tunnel temperature is controlled by aftercoolers and a cooling tower. Four 30,000 cubic-foot storage tanks provide dry air for tunnel pressurization.

TESTING CAPABILITIES: This tunnel is used for force and moment, pressure, internal air flow-inlet, and dynamic stability tests. A traversing strut which supports the sting body is mounted vertically down stream from the test section. Internal, strain-gage balances are used for measuring forces and moments. Facilities for measuring multiple steady or fluctuating pressures are available. A schlieren system is available for the study of flow patterns by direct viewing or photographing. Also, a system for obtaining 20 by 40-inch photographic shadowgraph negatives is available. Data are recorded on a Beckman 210 Medium-Speed recorder and processed through a centrally located Honeywell H-800 computer system.

FACILITY COST HISTORY

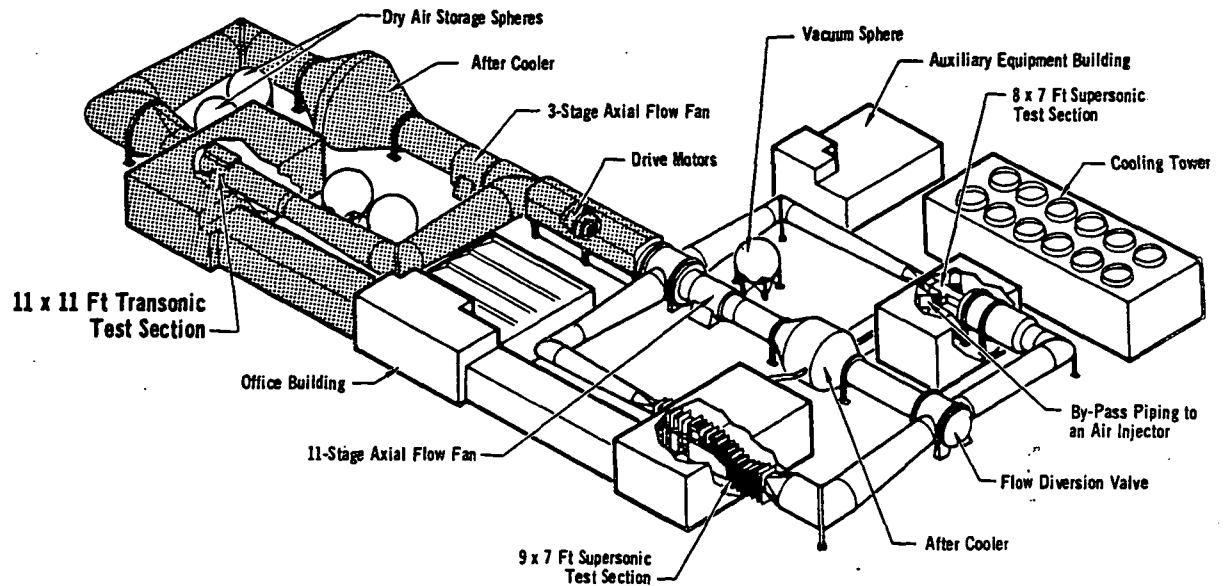
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$6600**	CONSTRUCTION YEAR: 1955 COST \$24,848,000* ESTIMATED REPLACEMENT VALUE \$53,987,000*
CONTRACTOR: Carl N. Swenson; Chicago Bridge & Iron LOCATION: San Jose; San Francisco, California IMPROVEMENTS AND COSTS: *(1956-57) Compressor blades, drive motor, model support, data equipment, Cost \$4,030,000; (1958-60) 8' air by-pass system, calibration, transformers, Schlieren, Cost \$1,696,000; (1961-63) 9 x 7 air by-pass system, flow improvement, control room alterations, Cost \$1,568,000; (1964- 66) Line printers, equipment, angular velocity measurement equipment, Cost \$111,000; (1967-69) Cold Jet Simulator, Cost \$490,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

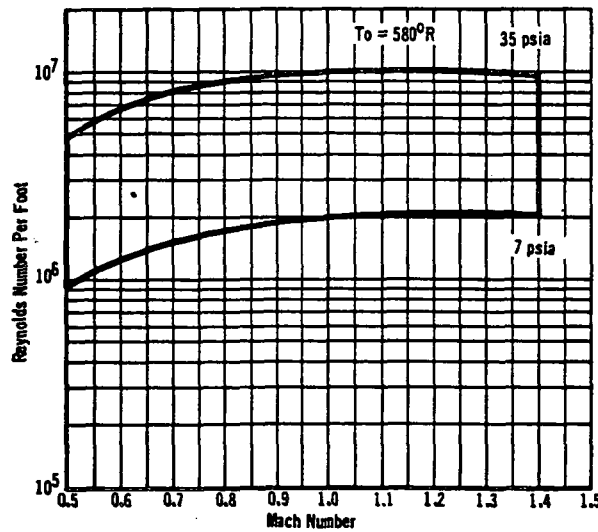
*All cost history is based on the three circuits in the Unitary Complex.

**Electric power and data reduction costs which vary widely from test to test are not included.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.5 to 1.4
Reynolds Number (x 10 ⁶ /ft):	1.7 to 9.4
Total Pressure (psia):	7 to 35
Dynamic Pressure (psf):	150 to 2000
Total Temperature (°R):	540 to 610
Run Time:	Continuous

NASA AMES 14-FOOT TRANSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-227-5 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Assistant Director for Aeronautics and Flight Aeronautics Division Experimental Investigations Branch
OTHER SOURCES OF INFORMATION: Vol. II ARC Research Facilities Summary, December 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Experimental Investigations Branch Phone: (415) 961-1111, ext 2746

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel was created by extensive modification of the former 16-foot diameter high speed tunnel. It is a closed circuit, single return, continuous flow, atmospheric type tunnel. The test section is slotted and is 13.5 feet by 13.9 feet by 33.75 feet. The nozzle has adjustable, flexible walls. Air temperature in the tunnel is controlled by an air exchanger. The tunnel air is driven by a three-stage, axial-flow compressor powered by three electric motors mounted in tandem outside the wind tunnel. The drive system is rated 110,000 horsepower continuously or 132,000 horsepower for one hour. The speed of the motors is continuously variable over the operating range.

TESTING CAPABILITIES: For conventional, steady-state tests, models are generally supported on a sting. Internal strain gage balances are used for measuring forces and moments. Facilities for measuring multiple steady or rapidly fluctuating pressures are available. For tests involving aerostuctural dynamics, model shakers with hydraulic power supply and appropriate readout facilities are available. A schlieren system for flow visualization is available, but vibration generally precludes fine definition. Various compact model motors and variable-frequency power to drive them at variable speeds are available. Data are recorded on a Beckman 210 Medium-Speed recorder and processed through a centrally located Honeywell H-800 computer system.

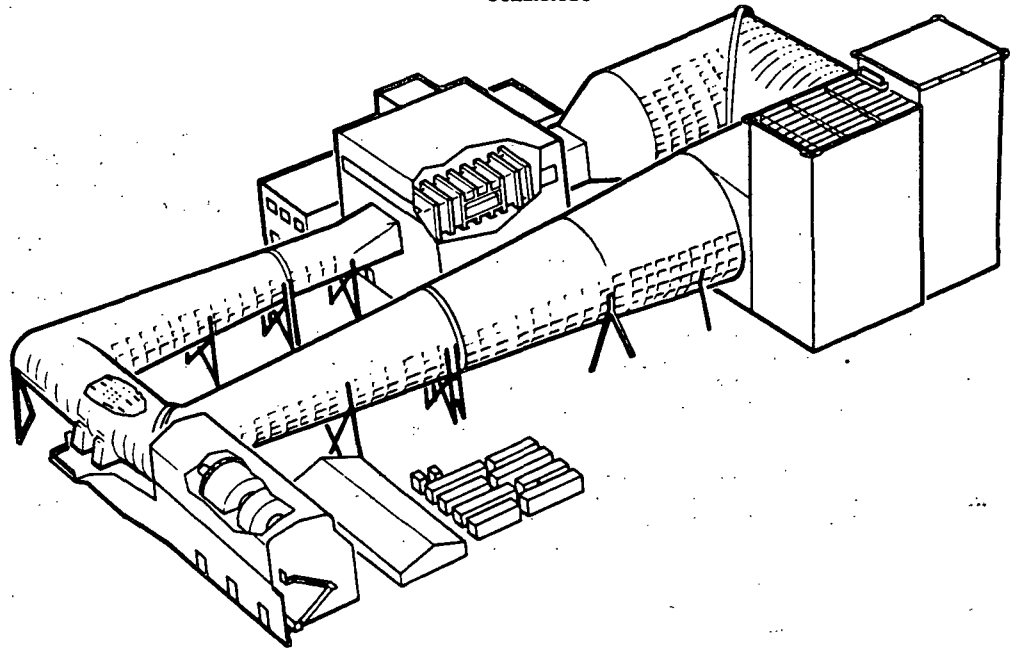
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$4000*	CONSTRUCTION YEAR: 1945; 1955 COST \$1.381M; 8.935M ESTIMATED REPLACEMENT VALUE \$21,429,000
CONTRACTOR: Leo Epp; Lew Jones Constr.; IMPROVEMENTS AND COSTS: (1956-57) Data handling equipment, camera, instrumentation, balances, Cost \$630,000; (1958-60) Modfn. to air exchange flaps, calibration of tunnel, Cost \$523,000; (1961-63) Sale of motor, balance, Cost \$44,000; (1964-66) Miscellaneous Modifications, Cost \$22,000; (1967-69) Miscellaneous Modifications, Cost \$119,000.	LOCATION: San Francisco; San Jose, Calif.

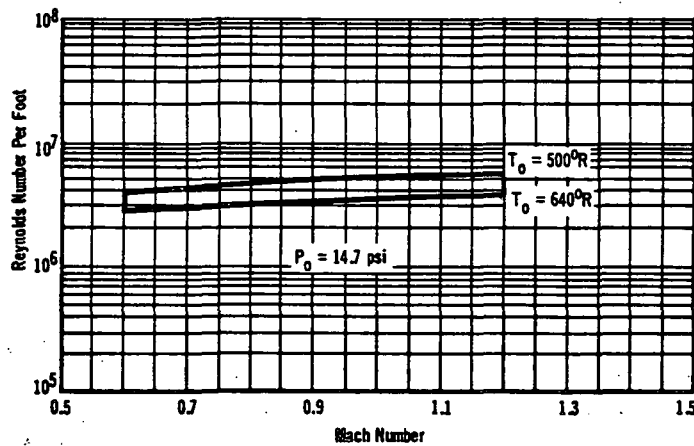
*Electric power and data reduction costs which vary widely from test to test are not included.

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.6 to 1.2 (continuously variable)
Reynolds Number ($\times 10^6/\text{ft}$):	2.8 to 5.2
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	425 to 885
Total Temperature ($^\circ R$):	500 to 640
Run Time:	Continuously

NASA AMES 2-FOOT BY 2-FOOT TRANSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-227-5 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Assistant Director for Aeronautics and Flight Mechanics Aeronautics Division Experimental Investigations Branch
OTHER SOURCES OF INFORMATION: Vol. II ARC Facilities Summary, Dec. 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Experimental Investigations Branch Phone: (415) 961-1111, ext. 2746

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a continuous flow, single return, closed circuit, variable density wind tunnel. The test section is 2 feet by 2 feet by 5 feet long and is slotted to permit transonic testing. This tunnel is equipped with an adjustable, flexible-wall nozzle. The tunnel air is driven by a two-stage, axial-flow compressor powered by four induction motors mounted in tandem. The drive system is rated at 4000 horsepower. The speed of the motors is continuously variable over the operating range.

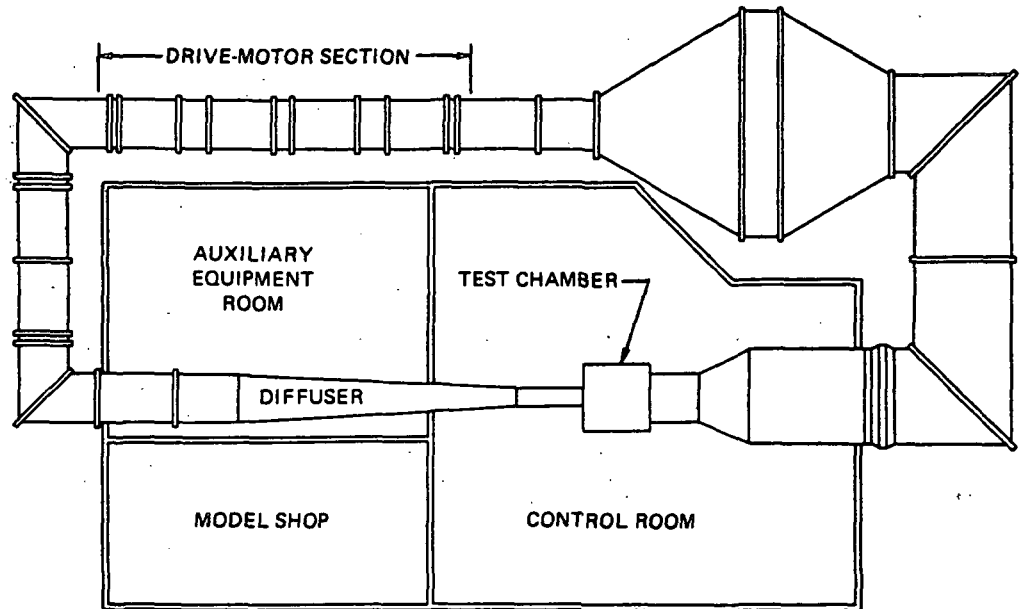
TESTING CAPABILITIES: This facility has been used extensively for panel-flutter tests in which a test section wall is replaced with a wall containing the test specimen. For conventional, steady state tests, models are generally supported on a sting. Internal, strain-gage balances are used for measuring forces and moments. Facilities for measuring multiple steady or fluctuating pressures are available. Data are recorded on a Beckman 210 Medium-Speed recorder and processed through a centrally located Honeywell H-800 computer system.

FACILITY COST HISTORY

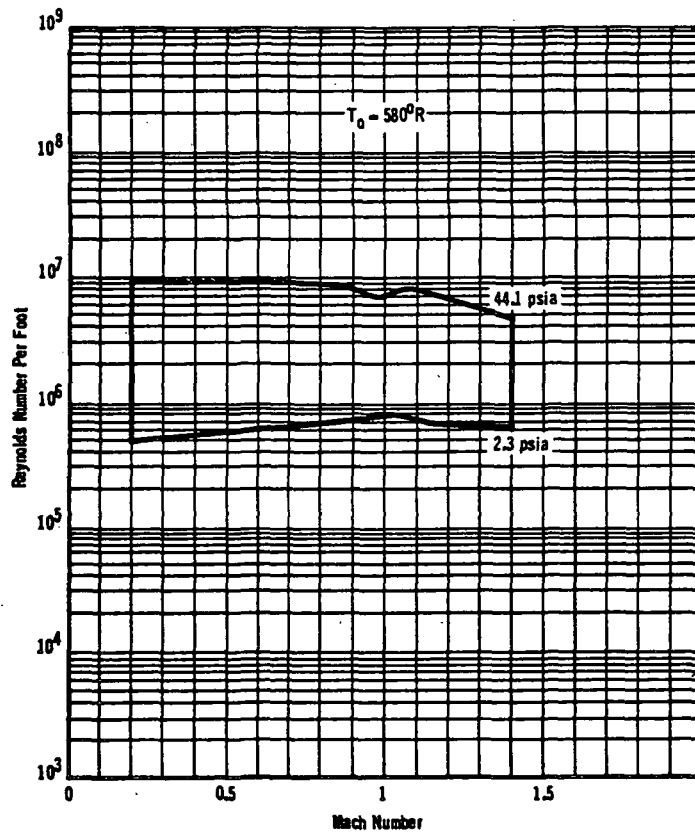
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2400*	CONSTRUCTION YEAR: 1951 COST \$ 447,000 ESTIMATED REPLACEMENT VALUE \$2,308,000
CONTRACTOR: In-House and Small Contracts	LOCATION:
IMPROVEMENTS AND COSTS: (1952-53) Miscellaneous, Cost \$33,000; (1954-57) Miscellaneous, Cost \$89,000; (1958-61) Air-removal system, Cost \$533,000; (1962-65) Air-removal system, Cost \$329,000; (1966-69) Sound reduction of control area and shop, Cost \$31,000.	
*Electric power and data reduction costs which vary widely from test to test are not included.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.2 to 1.4
Reynolds Number ($\times 10^6/\text{ft}$):	.5 to 8.7
Total Pressure (psia):	2.3 to 44.1
Dynamic Pressure (psf):	60 to 2175
Total Temperature ($^\circ R$):	580
Run Time:	Continuous

NASA AMES 9-FOOT BY 7-FOOT SUPERSONIC WIND TUNNEL (UNITARY)

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-227-5 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Assistant Director for Aeronautics and Flight Aeronautics Division Experimental Investigations
OTHER SOURCES OF INFORMATION: Vol. II, ARC Research Facilities Summary, December 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Experimental Investigations Branch Phone: (415) 961-1111, ext 2746

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is one of the supersonic legs of the Ames Unitary facility. It is a closed circuit, variable density, continuous flow tunnel. The test section is 9 feet by 7 feet by 18 feet and the nozzle is of the asymmetric, sliding-block type in which the variation of the test section Mach number is achieved by translating, in the streamwise direction, the fixed contour block that forms the floor of the nozzle. The temperature in all three circuits is controlled by aftercooling. Dry air for use in the circuits is supplied from four 30,000 cubic-foot spherical tanks. The tunnel air is driven by an 11-stage, axial-flow compressor powered by four wound-rotor induction motors. The same motors and compressor serve the 8 by 7-foot tunnel. The motors have a combined output of 180,000 horsepower for continuous operation or 216,000 horsepower for one hour.

TESTING CAPABILITIES: For conventional, steady state tests, models are generally supported on a sting; internal, strain gage balances are used for measuring forces and moments. Facilities for measuring multiple steady state or fluctuating pressures are available. A schlieren system is available for the study of flow patterns by direct viewing or photography. Also, a system for the study of flow patterns by direct viewing or photography. Also, a system for obtaining 20-inch by 20-inch photographic shadow-graph negatives is available. Data are recorded on a Beckman 210 Medium-Speed recorder and processed through a centrally located Honeywell H-800 computer system.

FACILITY COST HISTORY

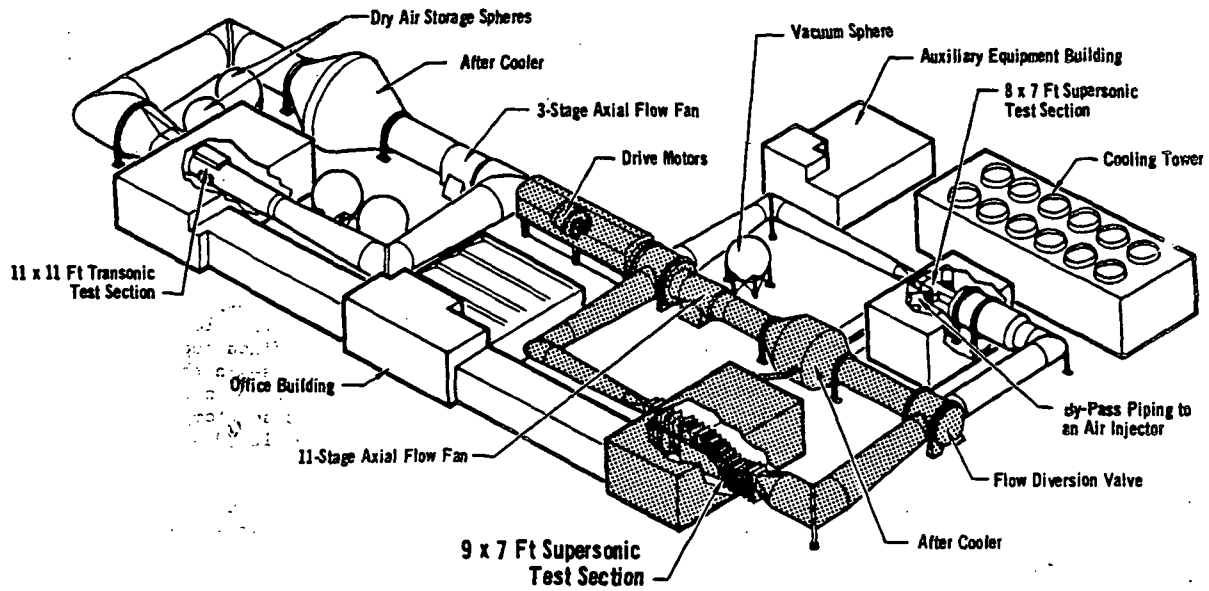
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$6600**	CONSTRUCTION YEAR: 1955 COST \$24,848,000* ESTIMATED REPLACEMENT VALUE \$53,987,000*
CONTRACTOR: Carl N. Swenson; Chicago Bridge & Iron	LOCATION: San Jose; San Francisco, Calif.
IMPROVEMENTS AND COSTS: *(1956-57) Compressor blades, drive motor, model support, data equipment, Cost \$4,030,000; (1958-60) 8' air bypass system, calibration, transformers, Schlieren, Cost \$1,696,000; (1961-63) 9 x 7 air bypass system, flow improvement, control room alterations, Cost \$1,568,000; (1964-66) Line printers, equipment, angular velocity measurement equipment, Cost \$111,000; (1967-69) Cold-Jet Simulator, Cost \$490,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

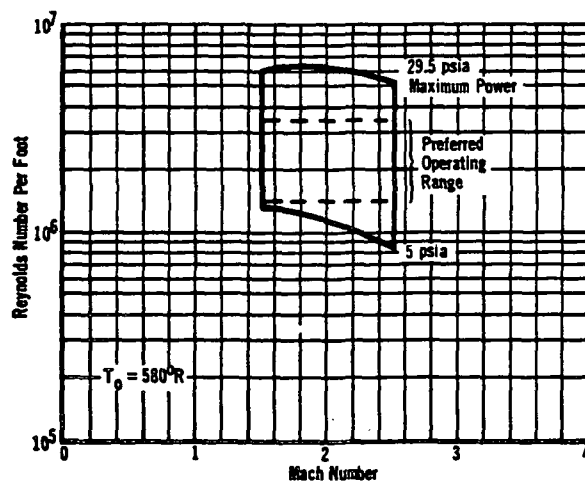
*All cost history is based on the three circuits in the Unitary Complex.

**Electric power and data reduction costs which vary widely from test to test are not included.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	1.55 to 2.55
Reynolds Number ($\times 10^6/\text{ft}$):	.8 to 6.5
Total Pressure (psia):	4.4 to 29.5
Dynamic Pressure (psf):	200 to 1450
Total Temperature ($^{\circ}\text{R}$):	580
Run Time:	Continuous

NASA AMES 8-FOOT BY 7-FOOT SUPERSONIC WIND TUNNEL (UNITARY)

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-227-5 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Assistant Director for Aeronautics and Flight Aeronautics Division Experimental Investigations Branch
OTHER SOURCES OF INFORMATION: Vol. II, ARC Research Facilities Summary, December 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Experimental Investigations Branch Phone: (415) 961-1111, ext 2746

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is one of the supersonic legs of the Ames Unitary facility. It is a closed circuit, variable density, continuous flow tunnel. The test section in this leg is 8 ft by 7 ft by 16 ft and the nozzle is a variable geometry type with flexible sides and a fixed top and bottom. The temperature in all three circuits is controlled by aftercooling. Dry air for use in the circuits is supplied from four 30,000 cubic-foot spherical tanks. The tunnel air is driven by an 11-stage, axial-flow compressor powered by four wound-rotor induction motors. The same motors and compressor serve the 9-foot by 7-foot supersonic wind tunnel. The motors have a combined output of 180,000 horsepower for continuous operation, or 216,000 horsepower for one hour.

TESTING CAPABILITIES: For conventional steady state tests, models are generally supported on a sting; internal, strain gage balances are used for measuring forces and moments. Facilities for measuring multiple steady or fluctuating pressures are available. A schlieren system is available for the study of flow patterns by direct viewing or photography. Also, a system for obtaining 20 by 20-inch photographic shadowgraph negatives is available. Data are recorded on a Beckman 210 Medium-Speed recorder and processed through a centrally located Honeywell H-800 computer system.

FACILITY COST HISTORY

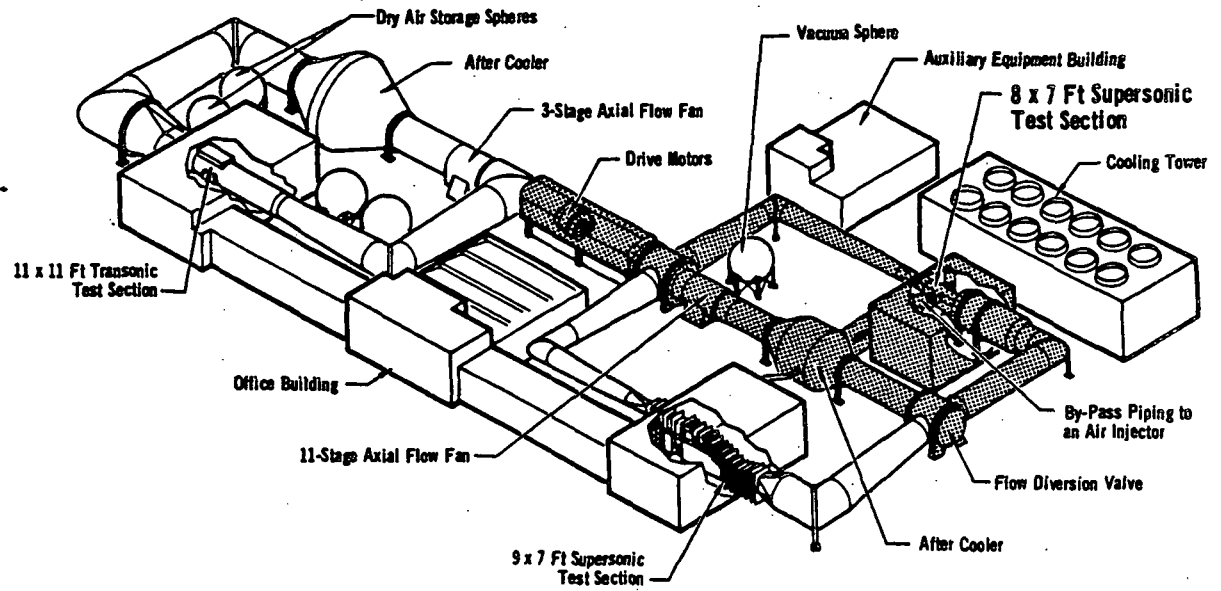
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$6600**	CONSTRUCTION YEAR: 1955 ESTIMATED REPLACEMENT VALUE \$53,987,000*
CONTRACTOR: Carl N. Swenson; Chicago Bridge & Iron LOCATION: San Jose; San Francisco, Calif. IMPROVEMENTS AND COSTS: *(1956-57) Compressor blades, drive motor, model support, data equipment, Cost \$4,030,000; (1958-60) 8' Air bypass system, calibration, transformers, Schlieren, Cost \$1,696,000; (1961-63) 9 x 7 air bypass system, flow improvement, control room alterations, Cost \$1,568,000; (1964-66) Line printers, equipment, angular velocity measurement equipment, Cost \$111,000; (1967-69) Cold-jet Simulator, Cost \$490,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

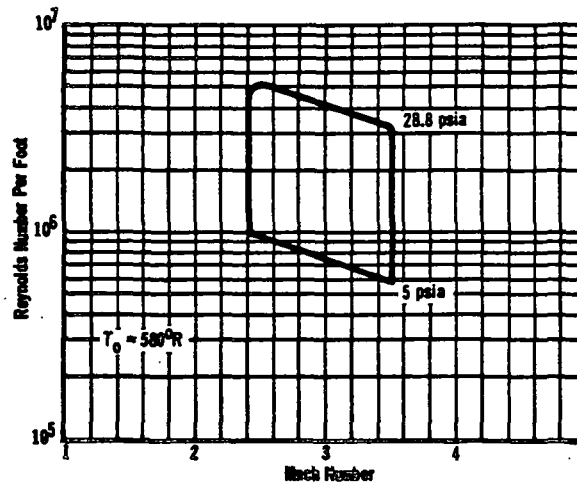
*All cost history is based on the three circuits in the Unitary Complex.

**Electric power and data reduction costs which vary widely from test to test are not included.

SCHMATIC



FACILITY PERFORMANCE DATA



Mach Range:	2.4 to 3.5
Reynolds Number ($\times 10^6/\text{ft}$):	.5 to 5.0
Total Pressure (psia):	4.4 to 28.8
Dynamic Pressure (psf):	200 to 1000
Total Temperature ($^{\circ}\text{R}$):	580
Run Time:	Continuous

NASA AMES 6-FOOT BY 6-FOOT SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-227-5 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Assistant Director for Aeronautics and Flight Mechanics Aeronautics Division, Experimental Investigations Branch
OTHER SOURCES OF INFORMATION: Vol. II ARC Research Facilities Summary, December 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Experimental Investigations Branch Phone: (415) 961-1111, ext 2746

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, continuous flow, single return type tunnel. The test section is 6 ft by 6 ft by 14 ft. A perforated test section floor and ceiling permits transonic tests. The nozzle is an asymmetric, sliding block type nozzle. The tunnel air is driven by an eight-stage, axial-flow compressor powered by two electric motors mounted in tandem outside the wind tunnel. The drive system is rated at 60,000 horsepower.

TESTING CAPABILITIES: The tunnel is capable of force and moment, pressure, and dynamic stability tests. For conventional steady state tests, models are generally supported on a sting. Internal, strain-gage balances are used for measuring force and moments. Facilities for measuring and recording multiple steady or rapidly fluctuating pressures are available. Schlieren and shadowgraph systems are available for flow visualization. Data are recorded on a Beckman 210 Medium-Speed recorder and processed through a centrally located Honeywell H-800 computer system.

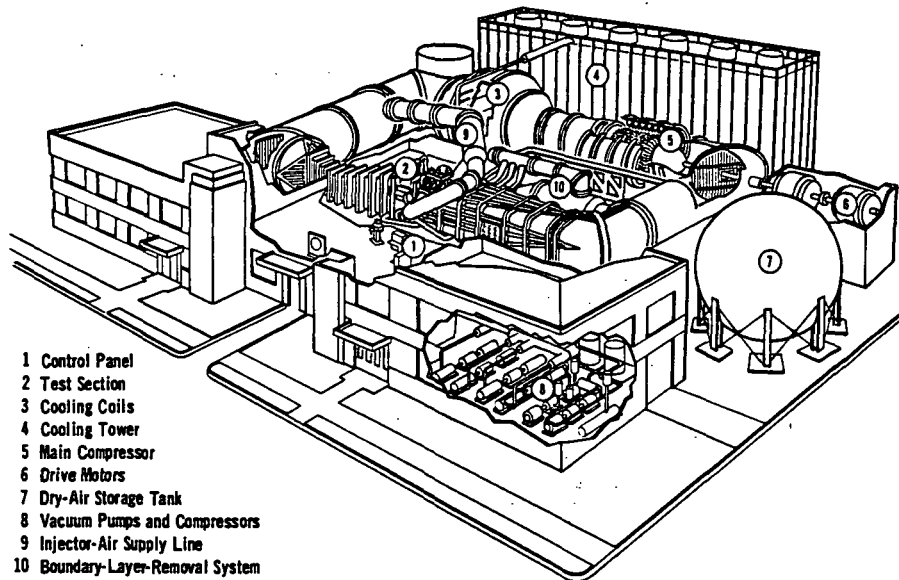
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$4000*	CONSTRUCTION YEAR: 1948 COST \$ 3,802,000 ESTIMATED REPLACEMENT VALUE \$12,410,000
CONTRACTOR: Pittsburgh Des Moines Steel Co. IMPROVEMENTS AND COSTS: (1949) Strain gage balance, recording system, survey, Cost \$214,000; (1950-54) Sting, printing units, Schlieren, model support, Cost \$985,000; (1955-59) Control system, misc. mods. to nozzle, etc., Cost \$1,310,000; (1960-64) Miscellaneous mods., Cost \$69,000; (1965-69) Miscellaneous mods., Cost \$21,000.	LOCATION: Pittsburgh, Pennsylvania

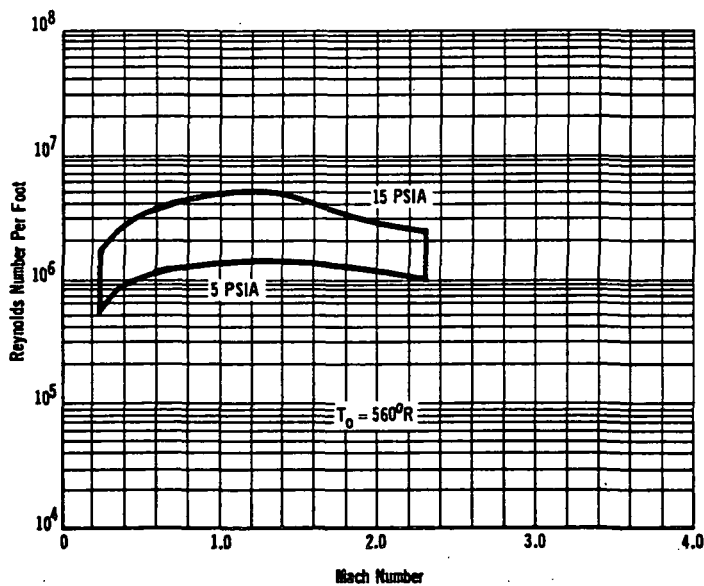
*Electric power and data reduction costs which vary widely from test to test are not included.

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.25 to 2.2
Reynolds Number ($\times 10^6/\text{ft}$):	.5 to 5
Total Pressure (psia):	4.4 to 14.7
Dynamic Pressure (psf):	200 to 1000
Total Temperature ($^\circ R$):	580 maximum
Run Time:	Continuous

NASA AMES 1-FOOT BY 3-FOOT SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-227-5 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Assistant Director for Aeronautics and Flight Aeronautics Division, Experimental Investigations, Branch
OTHER SOURCES OF INFORMATION: Vol II ARC Research Facilities Summary, December 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Experimental Investigations Branch Phone: (415) 961-1111, ext 2746

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is a closed circuit, continuous flow, variable density type tunnel. The test section is 1-foot wide by 5.5 feet long. The height of the test section may be varied from 1.25 feet to 2.8 feet depending on desired Mach number. The air is driven by four compressors operated in parallel for Mach 2.2 and lower. For the higher Mach numbers, two or three of the compressors are connected in parallel and operated in series with a larger compressor.

TESTING CAPABILITIES: Models for conventional, steady state tests are generally supported on a sting. The sting support system provides for large simultaneous variations in the vertical plane angle and the roll angle. The vertical plane angle can be varied ± 45 degrees. Special equipment is available for supersonic air inlet testing. Flow visualization equipment is available and schlieren photographs are readily obtained. Special arrangements must be made for shadowgraph pictures. Data are recorded on a Beckman 210 Medium-Speed recorder and processed through a centrally located Honeywell H-800 computer system.

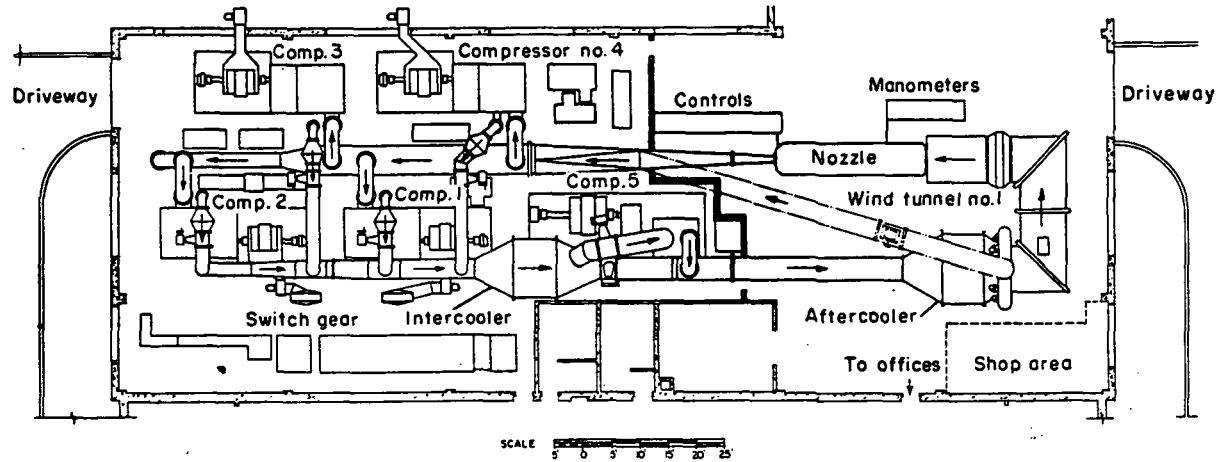
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2,400**	CONSTRUCTION YEAR: 1945 COST \$1,228,000 ESTIMATED REPLACEMENT VALUE \$9,211,000
CONTRACTOR: Pittsburgh Des Moines Steel Co.	LOCATION: Pittsburgh, Pennsylvania
IMPROVEMENTS AND COSTS: (1946-49) Nozzle calibration, acoustic partition, Cost \$134,000; (1950-54) Strain gauge balance, interferometer, revisions, Cost \$632,000; (1955-59) Extending range to supersonic, Cost \$1,272,000; (1960-64) Extending range, data processing system, Cost \$813,000; (1965-69) Arc heated air tunnels modification, Cost \$539,000.	

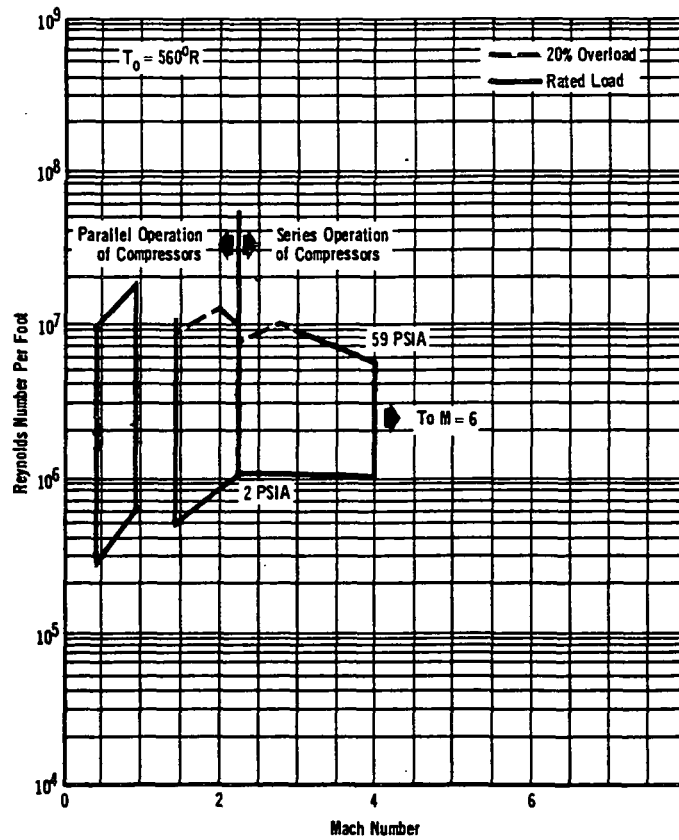
PLANS FOR FACILITY IMPROVEMENTS: None

*Electric power and data reduction costs which vary widely from test to test are not included.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: .4 to .9 and 1.4 to 6
 Reynolds Number ($\times 10^6/\text{ft}$): .5 to 12
 Total Pressure (psia): 1.91 to 58.8
 Dynamic Pressure (psf): 122 to 2500
 Total Temperature ($^\circ R$): 520 to 600
 Run Time: Continuous

NASA LANGLEY 8-FOOT TRANSONIC PRESSURE TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Full Scale Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Full Scale Research Division
OTHER SOURCES OF INFORMATION: "NASA Technical Memorandum, TMX-1130, July 1965"; "Characteristics of the Langley 8-Foot Transonic Tunnel With Slotted Test Sec., NACA Rpt 1389, 1958"	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, variable density, continuous flow type tunnel. The test section is 7.1 feet by 7.1 feet by 18 feet and is slotted for about 5 percent porosity. The tunnel is capable of operating at stagnation pressures above and below atmospheric pressure. The air temperature is controlled by finned cooling coils across one corner of the tunnel. Tunnel air can be dried by a dryer using silica gel as a desiccant. The tunnel is powered by a 25,000 hp main drive.

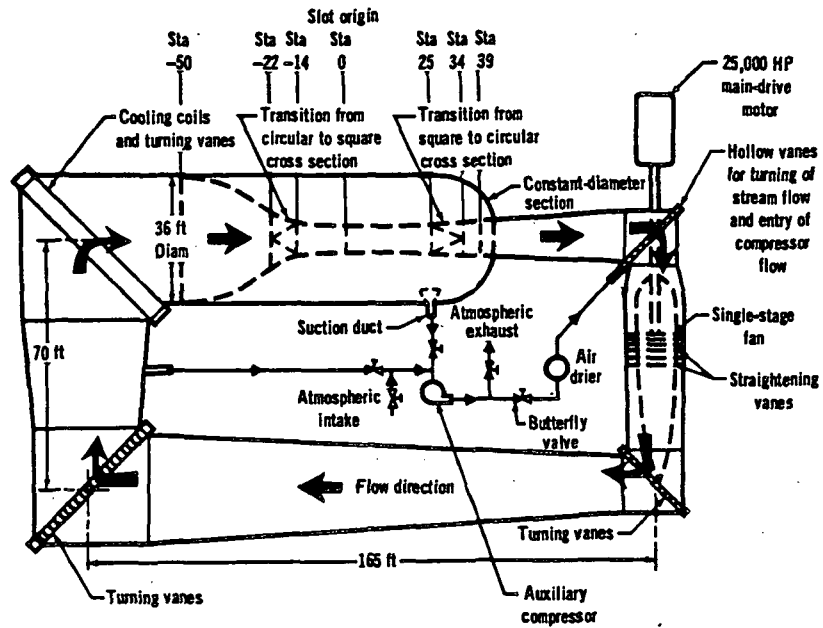
TESTING CAPABILITIES. The tunnel has a sting type model support system with tunnel wall mounts available. The tunnel is equipped with a schlieren system for flow visualization. Data recording is taken with 65 channels on a solid state high speed data acquisition system (SEL) and reduced on and off site. Steady force and pressure information is available. However, very little dynamic data recording equipment is available. Transonic buffet studies can be made.

FACILITY COST HISTORY

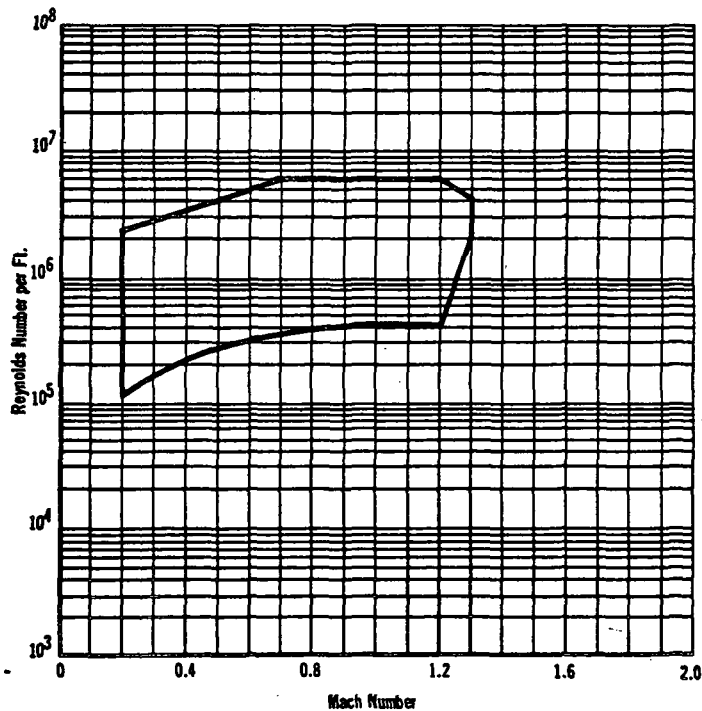
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1953 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.2 to 1.3
Reynolds Number ($\times 10^6/\text{ft}$):	.1 to 6
Total Pressure (psia):	1.5 to 29.5
Dynamic Pressure (psf):	6 to 1260
Total Temperature ($^{\circ}\text{R}$):	580
Run Time:	Continuous

NASA LANGLEY 4 BY 4-FOOT SUPERSONIC PRESSURE TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Full Scale Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Full Scale Research Division
OTHER SOURCES OF INFORMATION: "Characteristics of Nine Research Wind Tunnels of the Langley Aeronautical Laboratory, NACA 1957"; NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow, variable density type tunnel. The test section is nominally 4.5 feet by 4.5 feet by 7 feet long. The Mach number is changed by jacking the flexible upper and lower walls against interchangeable templates. Test section height varies from 51 to 64 inches depending upon Mach number. Distance between the side walls is fixed at 54 inches. Cooling coils and a dry air supply (air storage capacity is 10,000 cu ft at 125 psia) are used to change tunnel pressure and to maintain a low residual dewpoint. The tunnel is powered by a 45,000 hp main drive motor.

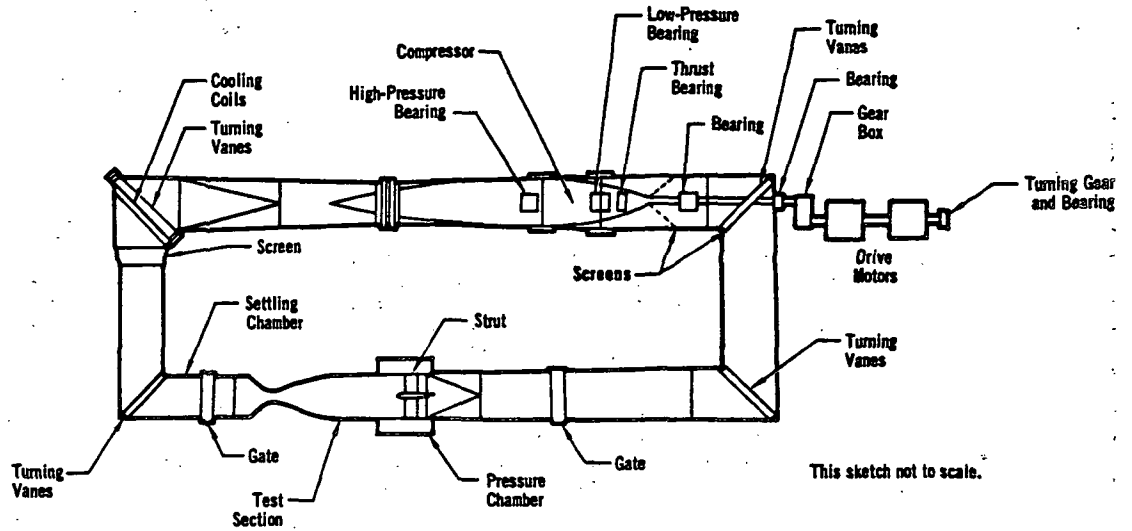
TESTING CAPABILITIES: This tunnel is used for force, moment, pressure, and propulsion studies. Model mounting provisions consist of various sting arrangements including axial and lateral movement and side wall support. Propulsion simulation studies can be made using dry, high-pressure air (15 lb/sec at 1000 psi) with an air system and model mounting apparatus ($\alpha = 0^\circ$) that is compatible with identical systems in the Langley 16-foot transonic tunnel and ground test stand. A schlieren system is available. Data are recorded with 99 channels on a Beckman 210 and reduced off site with a CDC 6600 computer system.

FACILITY COST HISTORY

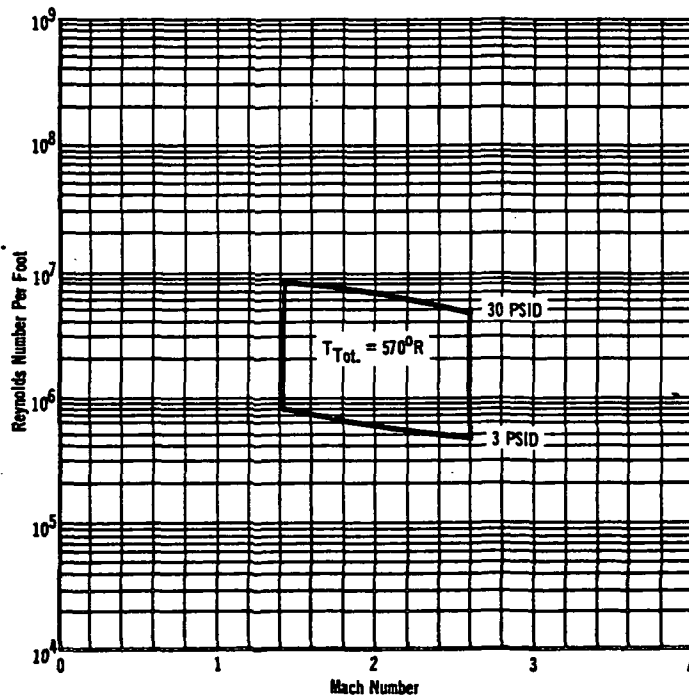
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1948 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: (1950) Increase horsepower to 45,000	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	1.25 to 2.6
Reynolds Number ($\times 10^6/\text{ft}$):	1.4 to 6.6
Total Pressure (psia):	4 to 30
Dynamic Pressure (psf):	250 to 1368
Total Temperature ($^\circ R$):	570
Run Time:	Continuous

NASA LANGLEY 9 BY 6-FOOT THERMAL STRUCTURES TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Structures Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Structures Research Division
OTHER SOURCES OF INFORMATION: "NASA Technical Note, TND-921, October 1961", NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to atmosphere tunnel with an 8.75-foot by 6-foot by 10-foot test section. The tunnel has a supersonic two-dimensional contoured nozzle and the tunnel air is heated by a metallic mass heat exchanger. The test medium is air plus combustion products heated by a gas-fired central core.

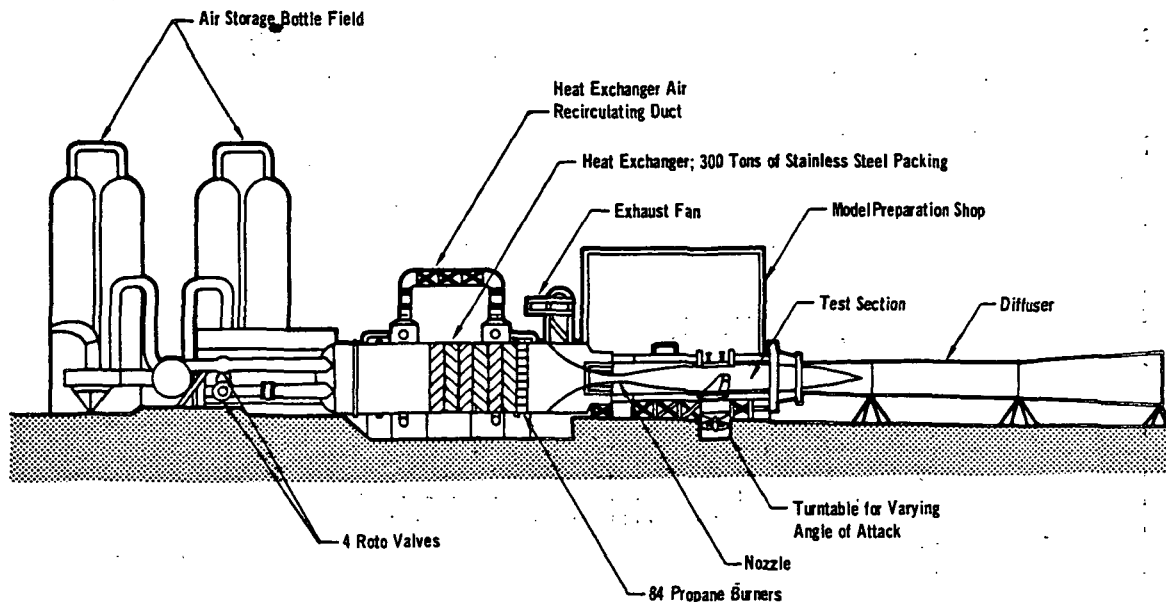
TESTING CAPABILITIES: This tunnel is used primarily for studies of aerodynamic heating and loading. Model mounting consists of sting, floor or panel mounts. Limited data recording instrumentation is available. A 1/12th-scale, or 9- x 6-inch model tunnel is available at the facility for determination of blockage and interference effects on 1/12th scale models or proposed test models and fixtures. This tunnel does not have a heat exchanger for pre-heating of the air but does include a boost heater system to provide temperatures to 2500°F for approximately 50 percent of the test section flow. Time-variant conditions are available for dynamic pressures. Running times are limited to 180 seconds or less. The 9- x 6-inch model tunnel is available for limited use. Data are reduced at the Langley Central Data Reduction Center and tie-ins.

FACILITY COST HISTORY

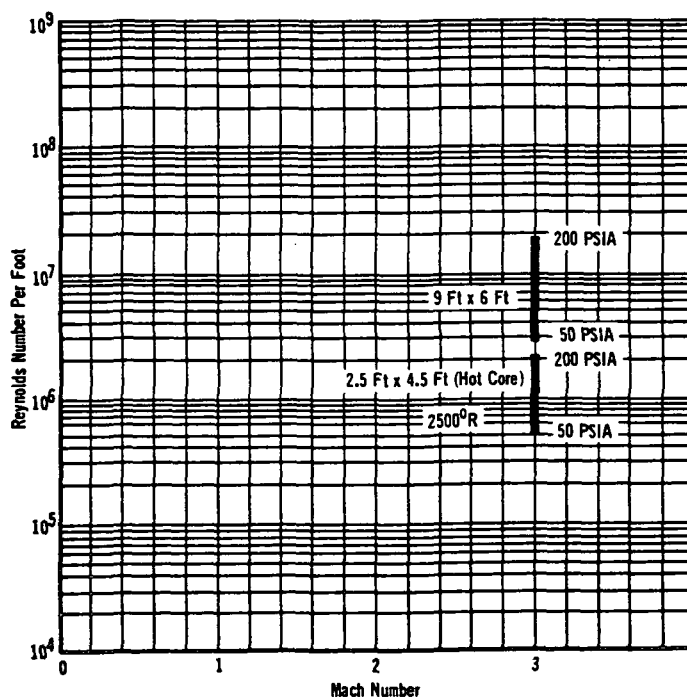
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1957 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Section 1

Mach Range:	3
Reynolds Number ($\times 10^6/\text{ft}$):	2.9 to 29.2
Total Pressure (psia):	50 to 200
Dynamic Pressure (psf):	1230 to 4940
Total Temperature ($^{\circ}\text{R}$):	560 to 1120
Run Time (seconds):	15 to 75

Hot Core

Mach Range:	3
Reynolds Number ($\times 10^6/\text{ft}$):	1.0 to 4.1
Total Pressure (psia):	50 to 200
Dynamic Pressure (psf):	1240 to 4960
Total Temperature ($^{\circ}\text{R}$):	2500
Run Time:	25 to 75

NASA LANGLEY 16-FOOT TRANSONIC TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Full Scale Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Full Scale Research Division
OTHER SOURCES OF INFORMATION: "Air Flow and Power Characteristics of the Langley 16-Foot Transonic Tunnel with Slotted Test Section" NACA RM L52E01; NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow, atmospheric tunnel. Speeds up to Mach number 1.05 are obtained with the tunnel main drive fans. Speeds above Mach number 1.05 are obtained with a combination of main drive and test-section plenum suction. The slotted octagonal test section nominally measures 15.5 feet across the flats. The test section length is 22 feet for speeds up to Mach 1.0 and 8 feet for speeds above Mach number 1.0. The tunnel is equipped with an air exchanger with adjustable intake and exit vanes to provide some temperature control. This facility has a main drive of 60,000 hp. A 36,000 hp compressor provides test section plenum suction.

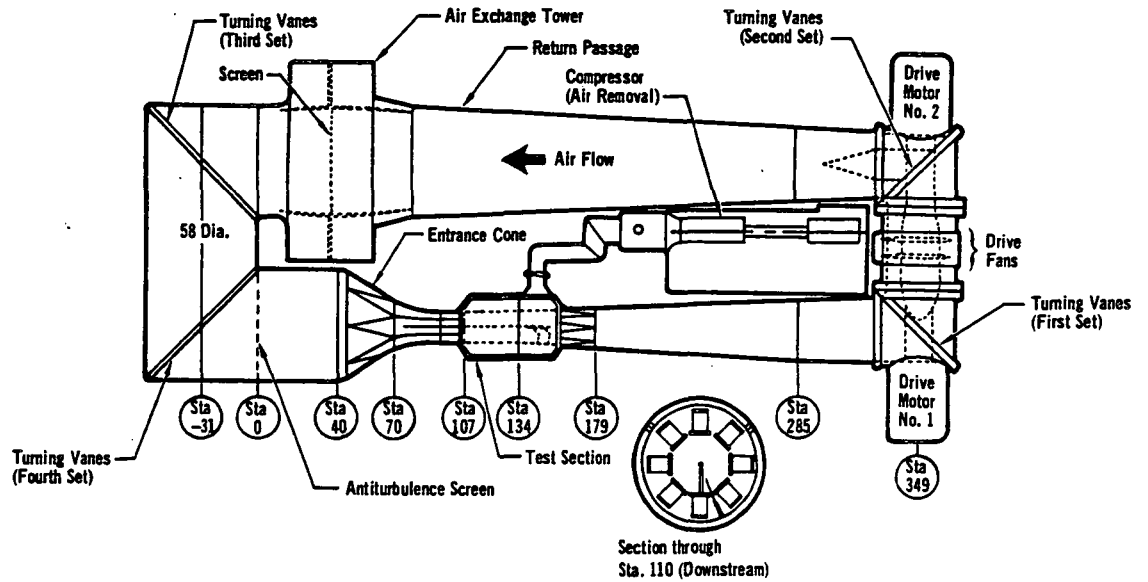
TESTING CAPABILITIES: This tunnel is used for force, moment, pressure, and propulsion-airframe integration studies. Model mounting consists of sting, sting-strut, and fixed strut arrangements. Propulsion simulation studies can be made for hot jet exhaust utilizing decomposition of hydrogen peroxide or using dry, cold, high pressure air. The high pressure (15 lb/sec at 1000 psi) air system and model mounting apparatus is compatible with identical systems in the Langley 4- by 4-foot supersonic pressure tunnel and ground test stand. A shadowgraph system is available for flow visualization. Data are recorded with 99 channels on a Beckman 210 and reduced off site with a CDC 6600 computer system.

FACILITY COST HISTORY

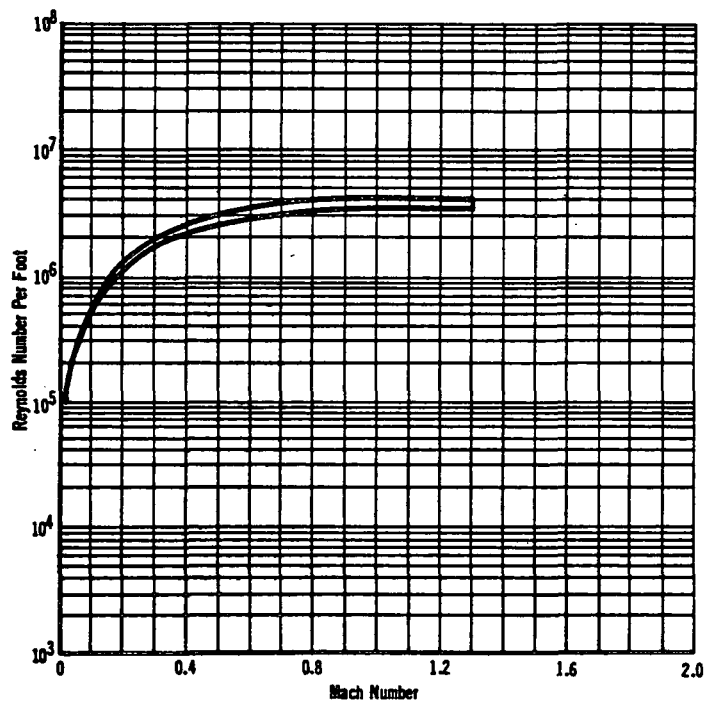
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1941 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: (1950) Converted the 16-Foot High Speed Wind Tunnel to the now existing facility. (1961) Test section air removal system added.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.2 to 1.3
Reynolds Number (x 10 ⁶ /ft):	1.2 to 3.7
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	57 to 905
Total Temperature (°R):	510 to 640
Run Time:	Continuous

NASA LANGLEY TRANSONIC DYNAMICS TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Dynamic Loads Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Dynamic Loads Division
OTHER SOURCES OF INFORMATION: NASA LWP-799, September 1969 NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow tunnel. The test section is 16 feet by 16 feet with a 30-foot uniform flow region at subsonic speeds and a 20-foot to 12-foot uniform flow region through the transonic range. The test medium is air or Freon-12. One set of corner vanes is equipped with a cooling system. This facility is powered by a 20,000 hp main drive.

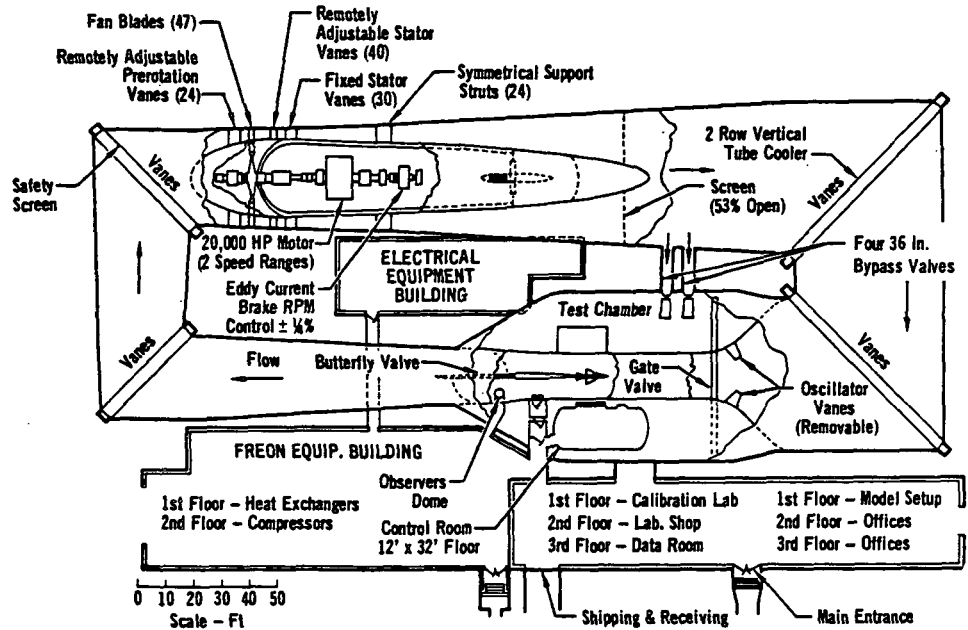
TESTING CAPABILITIES: The tunnel is used for investigation of aeroelastic phenomena such as flutter, buffeting, vortex shedding, gust loads, and other dynamic characteristics. Model mounting provisions consist of sting, floor, wall, and cable supports. Data recording and reduction varies to meet test needs.

FACILITY COST HISTORY

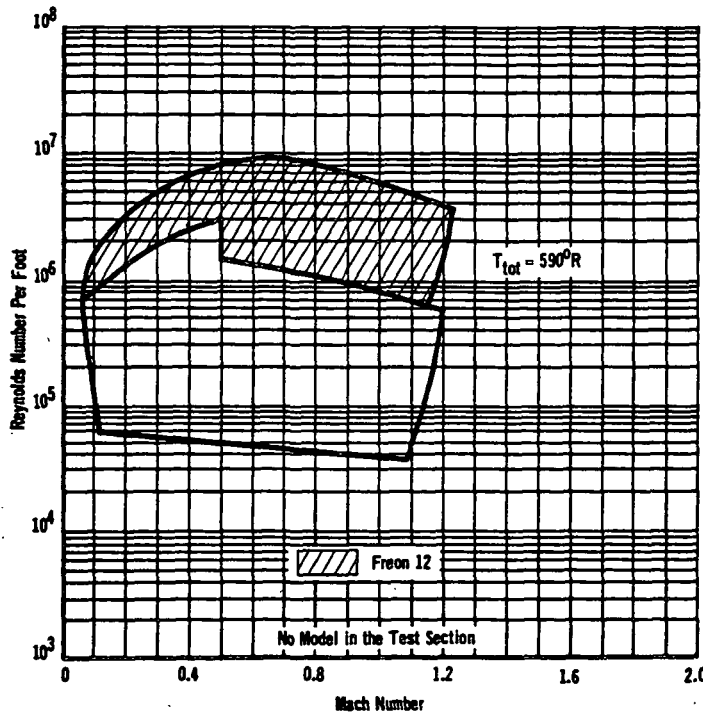
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1938 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: (1959) Major modification to test section and shell, complete new main drive and gas handling system.	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	0 to 1.2
Reynolds Number ($\times 10^6/\text{ft}$):	0 to 2.9 (Air) 0 to 9.7 (Freon-12)
Total Pressure (psia):	.1 to 14.7
Dynamic Pressure (psf):	0 to 320 (Air) 0 to 420 (Freon-12)
Total Temperature ($^\circ R$):	Ambient to 600
Run Time:	Continuous

NASA LANGLEY UNITARY PLAN WIND TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Full Scale Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Full Scale Research Division
OTHER SOURCES OF INFORMATION: "Manual for Users of the Unitary Plan Wind Tunnel Facilities, 1956"; NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, continuous flow, variable density type tunnel with two 4-foot by 4-foot by 7-foot test sections. The tunnel is equipped with a dry air supply (storage tanks with a 47,000 cu ft capacity at 150 psia), an evacuating system, a cooling system, and an asymmetric sliding block type nozzle. This facility is powered by a 100,000 hp (overload) main drive motor.

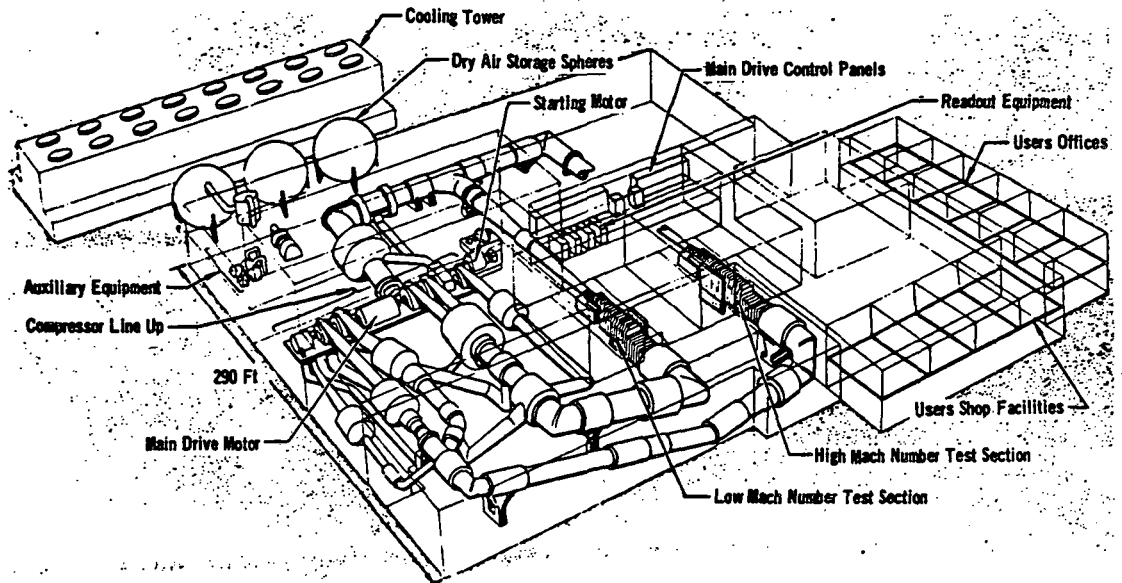
TESTING CAPABILITIES: The tunnel is used for jet effects (hot or cold), dynamic stability, force and moment, pressure distribution, and heat transfer studies. The normal operating temperature is approximately 150°F with heat bursts to 300°F available for heat transfer studies. Model mounting provisions consist of various sting arrangements, including axial, lateral, and rotary movement and sidewall support. A schlieren system, oil flow visualization, and sublimation are available in both sections. Data are recorded at the facility and reduced at the Langley Computer Center (CDC 6600). Data recording systems include Beckman, Scanivalve and B-4 type equipment providing 36 (B-4) channels, 217 Beckman channels and up to 540 pressure channels.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1955 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

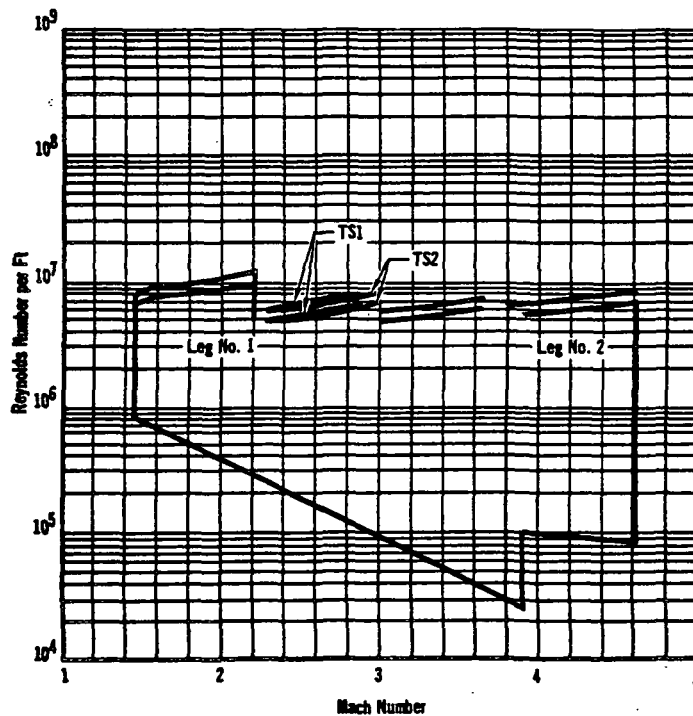
PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

LEG No. 1



Mach Range: 1.47 to 2.86
 Reynolds Number ($\times 10^6/\text{ft}$): .42 to 10.8
 Total Pressure (psia): 3 to 50.9
 Dynamic Pressure (psf): 83 to 1550
 Total Temperature ($^{\circ}\text{R}$): 610
 Run Time: Continuous

LEG No. 2

Mach Range: 2.29 to 4.63
 Reynolds Number ($\times 10^6/\text{ft}$): .57 to 8.1
 Total Pressure (psia): 3 to 142
 Dynamic Pressure (psf): 90 to 1075
 Total Temperature ($^{\circ}\text{R}$): 610 to 635
 Run Time: Continuous

NASA LEWIS 10- BY 10-FOOT SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION NASA Lewis Research Center 21000 Brookpark Road Cleveland, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Advanced Systems Division
OTHER SOURCES OF INFORMATION: NASA, "10- by 10-Foot Supersonic Wind Tunnel", Lewis Research Center, June 1959.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Advanced Systems Division Org Code: 9600 Phone: (216) 433-4000, ext 421

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility operates on either an aerodynamic cycle (at various air densities) or on a propulsion cycle. On the aerodynamic cycle, the tunnel operates as a closed return type tunnel, and on the propulsion cycle, it operates as an open nonreturn type tunnel. A flexible plate nozzle is used to provide Mach number control into the test section which is 10 by 10 feet in cross-section by 40 feet in length. Air entering the first and second compressors is cooled by two finned-tube, water-coil type heat exchangers. The air is dried by an activated alumina drier. An exhaust muffler is used to quiet the discharge air when the tunnel is operated as an open (propulsion) circuit.

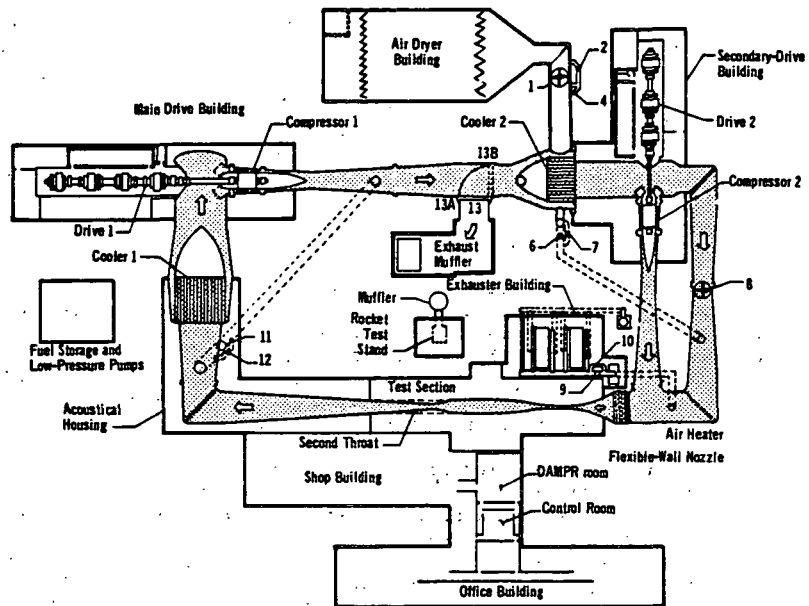
TESTING CAPABILITIES: The tunnel is used for force and moment, pressure, heat transfer, flutter, internal duct flow, jet effects (hot or cold), rocket, and live engine tests. The tunnel is equipped with a sting, a strut, and a suspended model auxiliary strut for rakes used in conjunction with a suspended model. The whole floor of the test section is capable of being lowered to the first floor level by means of four long screw jacks located at the corners of the floor. Two schlieren systems and a TV monitoring system are available for flow visualization. The data acquisition system is part of the Control Automatic Digital Data Encoder (CADDE) which is used by many of the laboratory's major test facilities to record digital readings from test instrumentation. Data from the CADDE equipment are processed by an ERA 1103 (Engineering Research Associates) general-purpose computer.

FACILITY COST HISTORY

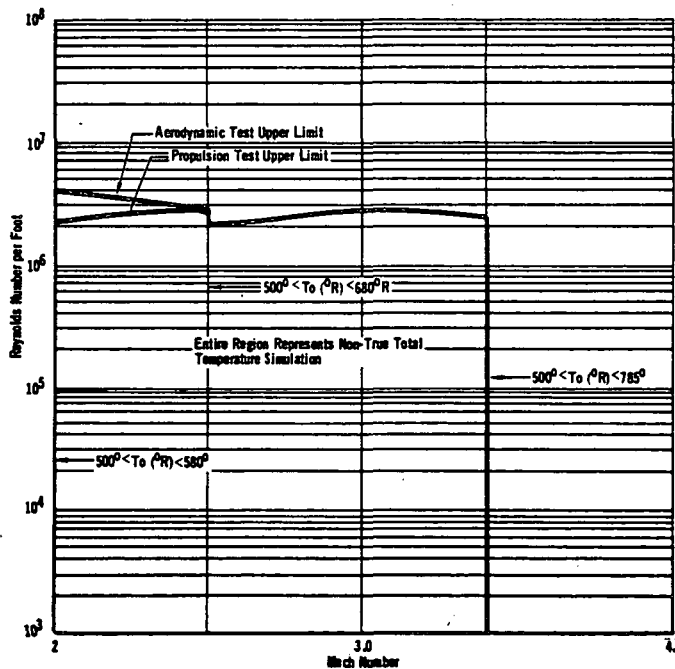
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS:	

PLANS FOR FACILITY IMPROVEMENTS: None.

SCHEMATIC



FACILITY PERFORMANCE DATA



Aerodynamic Cycle

Mach Range:	2 to 3.5
Reynolds Number ($\times 10^6/\text{ft}$):	.12 to 3.35
Total Pressure (psia):	1.47 to 34.7
Dynamic Pressure (psf):	20 to 720
Total Temperature (°R):	1160
Run Time:	Continuous

Propulsion Cycle

Mach Range:	2 to 3.5
Reynolds Number ($\times 10^6/\text{ft}$):	2.1 to 2.68
Total Pressure (psia):	9.1 to 34.7
Dynamic Pressure (psf):	500 to 600
Total Temperature (°R):	1160
Run Time:	Continuous

NASA LEWIS 8 BY 6-FOOT SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Lewis Research Center 21000 Brookpark Road Cleveland, Ohio 44135	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Advanced Systems Division
OTHER SOURCES OF INFORMATION: NASA, "8- By 6-Foot Supersonic Wind Tunnel", Lewis Research Center, February 1959.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Advanced Systems Division Org Code: 9600 Phone: (216) 433-4000, ext 421

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is a continuous operation return or nonreturn wind tunnel with a controlled Mach number range of from 2.1 to a lower limit determined by model blocking and shock reflection. The flexible wall nozzle can be varied while the tunnel is operating to control test section Mach number. The tunnel can be operated on either an aerodynamic cycle (closed circuit) or propulsion cycle (open circuit). In the propulsion cycle, the air enters an alumina air dryer which is capable of absorbing approximately 1 ton of water per minute. The air then enters a plenum chamber and the seven-stage axial flow compressor. The test section is 8 by 6 feet in cross section by 39 feet in length. The first half of the test section is the supersonic portion, and the last half is the transonic perforated section. In the propulsion cycle, the air is then exhausted to atmosphere. The aerodynamic or closed circuit mode is similar to the propulsion cycle, except that the air is cooled by a cooler located in the duct and returned to the dryer for recirculation.

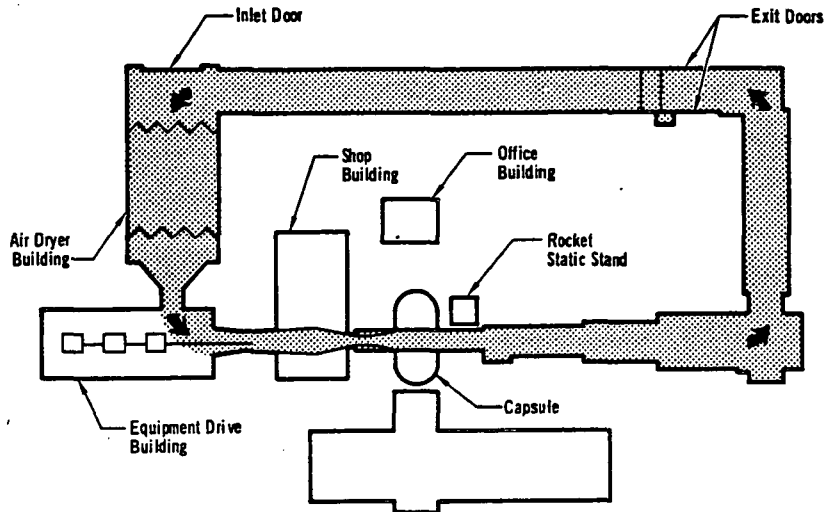
TESTING CAPABILITIES: This tunnel can accommodate force and moment, pressure, heat transfer, flutter, internal duct flow, jet effects (hot or cold), rockets and live engine tests. There are several model supports available: ceiling strut mounts, a supersonic sting mount, a transonic sting, and supersonic and transonic jet exit wing mounts. However, users may furnish their own support systems. Supersonic and transonic schlieren systems are available for flow visualization. The data acquisition system is built around the Central Automatic Digital Data Encoder (CADDE) which is used by many of the major facilities at the Lewis Research Center to record digital readings from test instrumentation. After recording, the data are processed on a stored program, high speed, general purpose digital computer (i.e., a Sperry Rand type 1103 Scientific Univac).

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS:	LOCATION:

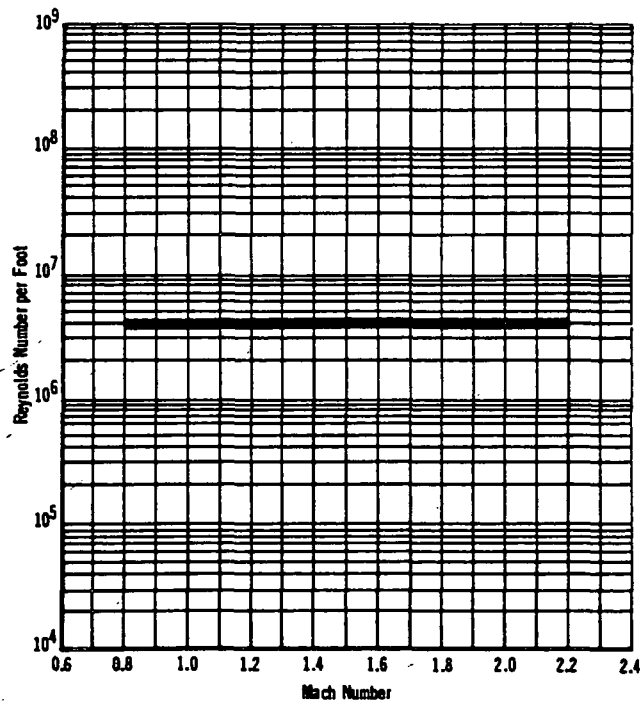
PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



Note: Inlet and exit doors are closed for the aerodynamic cycle, and open for the propulsion cycles.

FACILITY PERFORMANCE DATA



Mach Range:	.8 to 2.1
Reynolds Number ($\times 10^6/\text{ft}$):	4.2 to 4.8
Total Pressure (psia):	15.5 to 25.4
Dynamic Pressure (psf):	650 to 1240
Total Temperature ($^{\circ}\text{R}$):	600 to 700
Run Time:	Continuous

NOL SUPERSONIC TUNNEL NO. 1

REPORTING INSTALLATION: U.S. Naval Ordnance Laboratory Silver Spring, Maryland 20910	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Applied Aerodynamics Division, Aerodynamics Department
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation). Bldg. 402 Phone: (301) 434-7100, ext

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is an intermittent blowdown to vacuum type tunnel with a 16 by 16 inch test section, which is 5 feet long with an open jet. This facility is equipped with contoured and conical blast wave nozzles. All subsonic Mach numbers are obtained with one nozzle and are controlled by adjusting the diffuser. The tunnel is equipped with a drier containing a filter of silica gel.

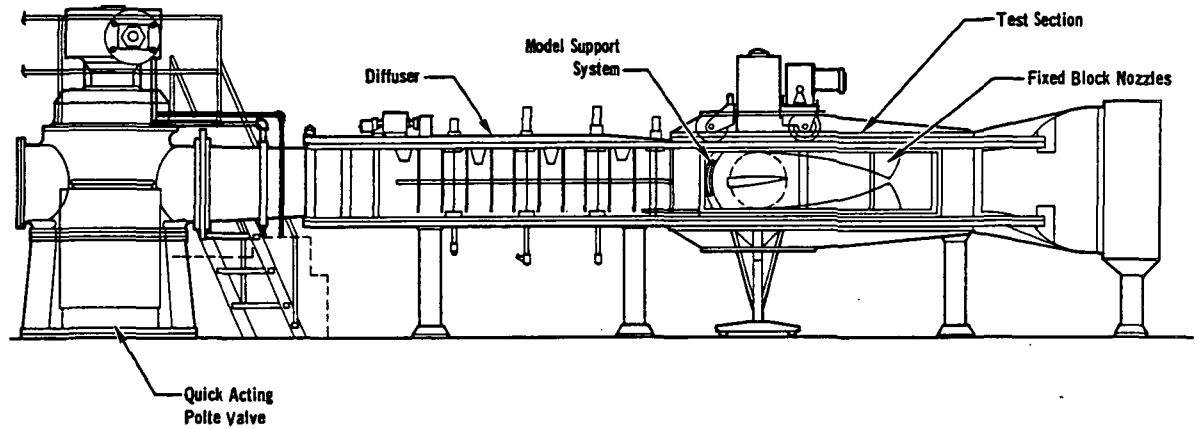
TESTING CAPABILITIES: This tunnel is used for static stability measurements, pitch and roll damping and fuze tests, Magnus investigations, and specialized tests such as free-flight testing and blast-interaction experiments. The interaction between a blast wave and a reentry body is accomplished by mounting a shock tube upstream of the nozzle throat and firing a plane blast wave through the nozzle and over the model mounted in the test section. Models are mounted on variable angle sting and strut type supports. Data are recorded with 32 channels on a computer controlled multiplexed A-D to magnetic tape recording system and reduced off site with an IBM 7094. This facility is capable of 40 to 100 runs per day. A schlieren system is available.

FACILITY COST HISTORY

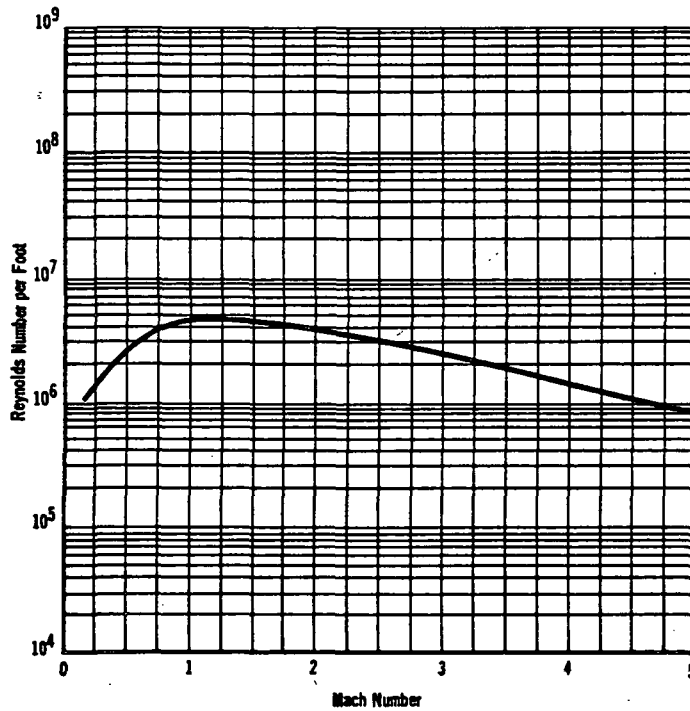
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$5600	CONSTRUCTION YEAR: 1949 COST \$ 671,000 ESTIMATED REPLACEMENT VALUE \$1,000,000
CONTRACTOR: U.S. Naval Ordnance Laboratory	LOCATION: Silver Spring, Maryland
IMPROVEMENTS AND COSTS: (1954) Seven (7) new nozzles, Cost \$40,000.	

PLANS FOR FACILITY IMPROVEMENTS: Plan to increase test section by a factor of four to do supersonic store separation testing.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.05 to 5
Reynolds Number ($\times 10^6/\text{ft}$):	.8 to 4.6
Total Pressure (psia):	14 to 14.7
Dynamic Pressure (psf):	0 to 878
Total Temperature ($^{\circ}\text{R}$):	500 to 565
Run Time (seconds):	20

NOL SUPERSONIC TUNNEL NO. 2

REPORTING INSTALLATION: U.S. Naval Ordnance Laboratory Silver Spring, Maryland 20910	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Applied Aerodynamics Division, Aerodynamics Department
OTHER SOURCES OF INFORMATION: Report No. NOLR 1233; "The New NOL Supersonic Tunnel No. 2", 1962	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation), Building 42 Phone: (301) 434-7100, ext 564 or 570

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is a closed circuit, recirculating or blowdown, variable density type tunnel with a 16-inch by 16-inch by 8-foot test section and an open jet in the test chamber. The nozzles (12) are interchangeable with those of Supersonic Tunnel No. 1. For transonic tests a perforated wall nozzle is used. All subsonic Mach numbers are obtained with one nozzle and are controlled by adjusting the diffuser. This tunnel has been modernized for higher pressure and higher temperature operation. The test section, diffuser, and model support system have been replaced and a steam heater, particle filter, and two new nozzles have been added. With the longer test section, it is possible to use longer, high-Mach number nozzles which will produce a more uniform flow. The tunnel has a series of pumps, a large vacuum sphere, and an air drier. A settling chamber designed for 15 atmospheres pressure precedes the test section to reduce the turbulence level of the air.

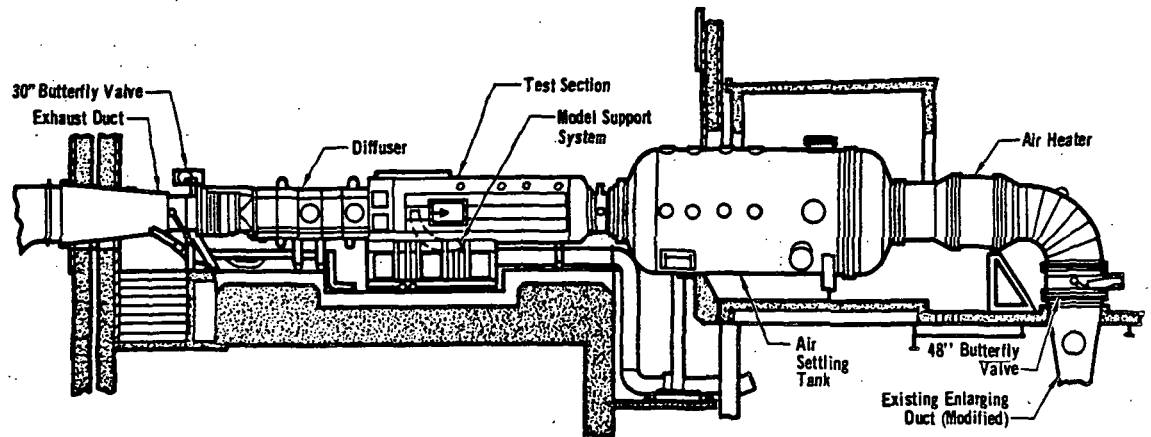
TESTING CAPABILITIES: This tunnel is used for static stability measurements, pitch and roll damping tests, Magnus investigations, and specialized tests such as computer controlled free-flight testing. This tunnel, because it can operate continuously and over a wide range of Reynolds numbers, is ideal for pressure distribution tests and heat-transfer measurements. Model mounting consists of variable angle sting or strut type supports. A schlieren system and high speed photography are available for flow visualization. As many as 112 channels of data are recorded with multiplex A-D to magnetic tape and reduced on site with an IBM 7090 reduction system.

FACILITY COST HISTORY

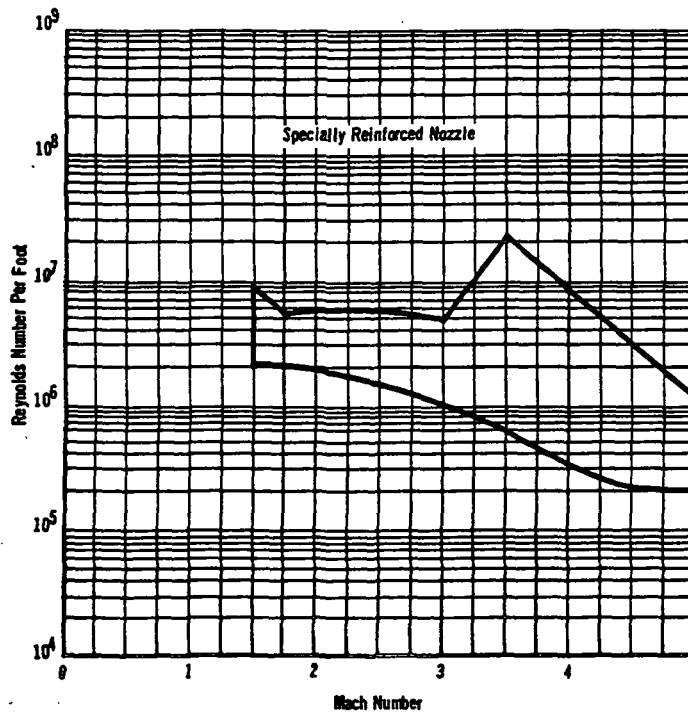
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$6400	CONSTRUCTION YEAR: 1962 COST \$ 671,000 ESTIMATED REPLACEMENT VALUE \$1,000,000
CONTRACTOR: U.S. Naval Ordnance Laboratory	LOCATION: Silver Spring, Maryland
IMPROVEMENTS AND COSTS: (1963) Schlieren System, Cost \$60,000, and New Diffuser, Cost: \$50,000.	

PLANS FOR FACILITY IMPROVEMENTS: This facility will also be made into a blowdown facility.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	1.5 to 5
Reynolds Number ($\times 10^6/\text{ft}$):	.05 to 38
Total Pressure (psia):	7.5 to 220
Dynamic Pressure (psf):	72
Total Temperature ($^{\circ}\text{R}$):	530 to 635
Run Time (seconds):	60 to 300

NOL BOUNDARY LAYER CHANNEL

REPORTING INSTALLATION: U.S. Naval Ordnance Laboratory Silver Spring, Maryland 20910	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aerophysics Division Aerodynamics Department
OTHER SOURCES OF INFORMATION: Report No. NOLTR 66-185	LOCAL OFFICE TO CONTACT FOR INFORMATION: Same as Reporting Installation Phone: (301) 434-7100, ext 8177

DESCRIPTION AND TESTING CAPABILITIES

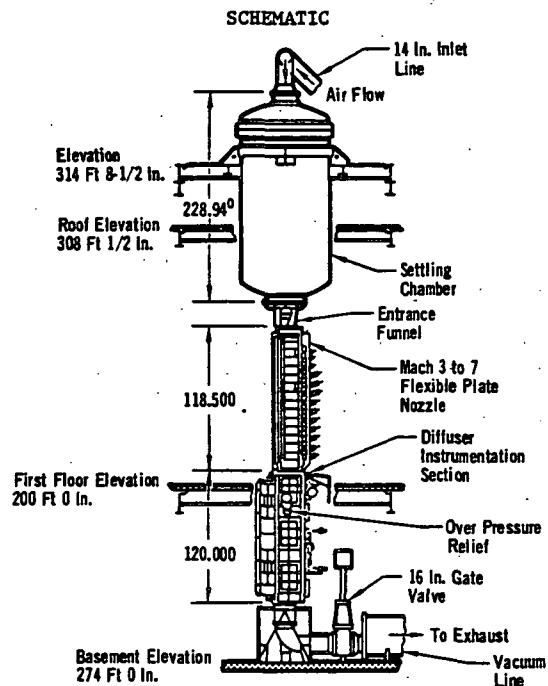
FACILITY DESCRIPTION: This facility is a blowdown to vacuum type tunnel. It consists of a two dimensional, adjustable half nozzle ten feet long. The tunnel test section is 12 by 12 by 60-inches with a 6 by 6-inch test core. This facility is equipped with a propane gas heater capable of 1400 Btu/sec. The driver gas (air or nitrogen) 2500 cu ft at 5000 psia is used to run this tunnel.

TESTING CAPABILITIES: This facility is capable of boundary layer studies (laminar, transitional and turbulent), and boundary layer interaction with surface protrusions and jets. Boundary layer studies are made on the flat wall opposite the flexible plate. This channel is equipped with a direct measuring skin friction balance and hot wire equipment. A digital voltmeter is used to record seven channels of data which are keypunched into IBM cards for off site processing.

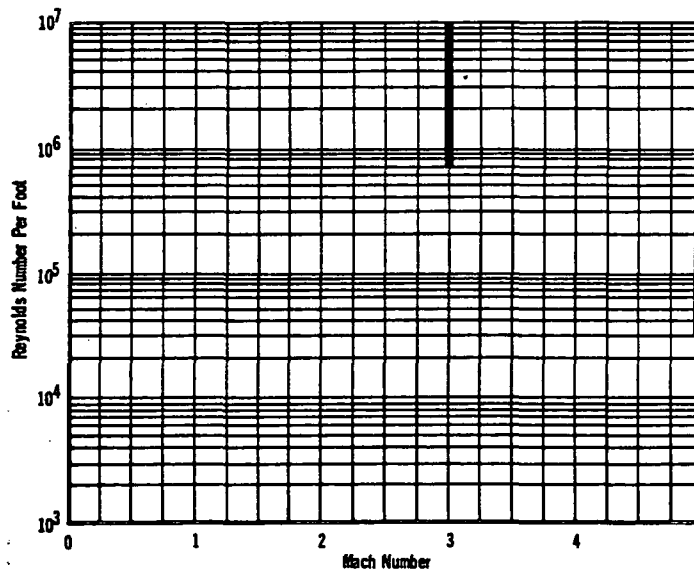
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$5600	CONSTRUCTION YEAR: 1965 COST \$365,000 ESTIMATED REPLACEMENT VALUE \$534,000
CONTRACTOR: U.S. Naval Ordnance Laboratory IMPROVEMENTS AND COSTS: (1969) New doors with windows, Cost \$20,000; (1969) Data acquisitions, Cost \$20,000; (1969) Nitrogen cooling, Cost \$40,000.	LOCATION: Silver Spring, Maryland

PLANS FOR FACILITY IMPROVEMENTS: New Schlieren System, Laser Velocimeter



FACILITY PERFORMANCE DATA



Mach Range: 3, 5
 Reynolds Number ($\times 10^6/\text{ft}$): .03 to 10
 Total Pressure (psia): .22 to 48.26
 Dynamic Pressure (psf): 36.3 to 175
 Total Temperature ($^{\circ}\text{R}$): 1410
 Run Time (seconds): 1800

NORTH AMERICAN ROCKWELL/COLUMBUS SUPERSONIC/TRANSONIC WIND TUNNEL (TSWT)

REPORTING INSTALLATION: North American Rockwell Corporation Columbus Division 4300 E. Fifth Avenue Columbus, Ohio 43216	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aircraft Research and Engineering
OTHER SOURCES OF INFORMATION: TSWT User's Manual No. NR69H-346	LOCAL OFFICE TO CONTACT FOR INFORMATION: Supervisor, Aerodynamic Laboratory Phone: (614) 231-1851, ext 2682

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to atmosphere facility with a 26-inch by 26-inch by 48-inch test section. Two interchangeable nozzle sections are used depending on the speed-range employed. In all cases, a common upper and lower nozzle frame remains in place. A conventional porous wall section with a porosity of 22 percent and a sonic nozzle are utilized for transonic operation. A solid set of sidewalls along with the conventional two-dimensional supersonic nozzles are employed for supersonic operations. A 6000 hp compressor provides 15 lb/sec air to produce 4500 psi air in tanks having 9000 cu ft of storage volume. The tunnel is equipped with a variable second throat diffuser and ejector system.

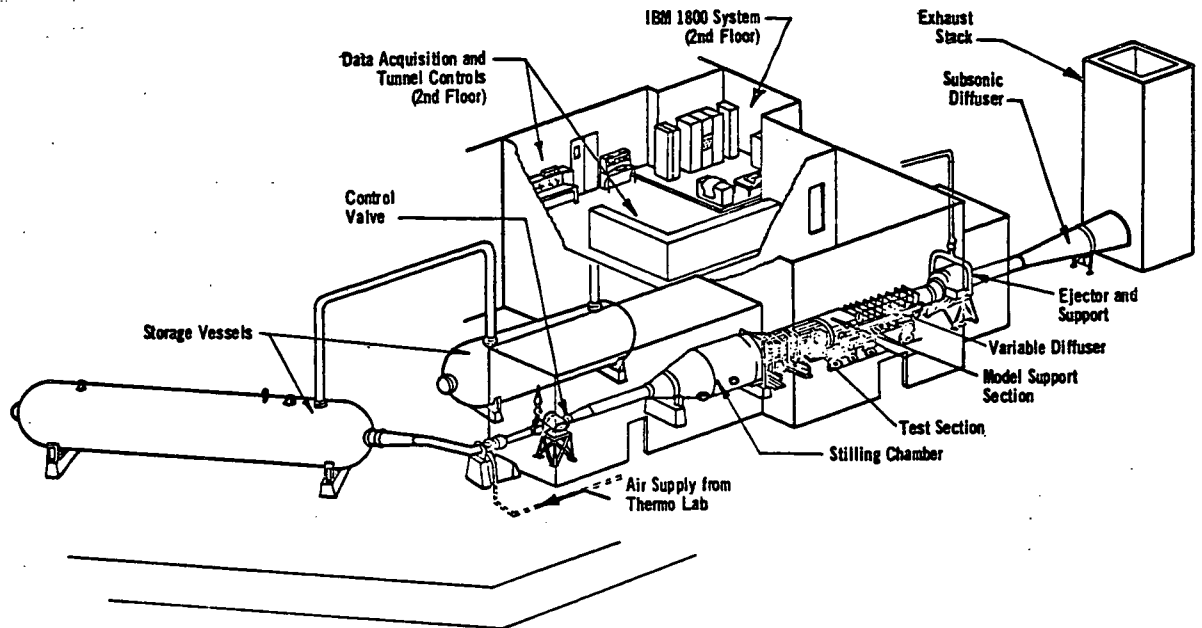
TESTING CAPABILITIES: This tunnel is used for force and moment, pressure, jet flow (cold), flutter and various other types of wind tunnel testing. Model mounting consists of variable angle sting and strut type mounts, semispan models on sidewall reflection plane and sidewall 5-component balances are available. Tunnel performance data, as well as test model data are recorded (50 channels) and processed on line with an IBM 1800 Data Acquisition and Processing System. On-line plots are available from a bank of ten (10) X-Y plotters located in the control room. Final comparison plots are completed off line on a Milgo automatic plotter. A single pass schlieren system is available.

FACILITY COST HISTORY

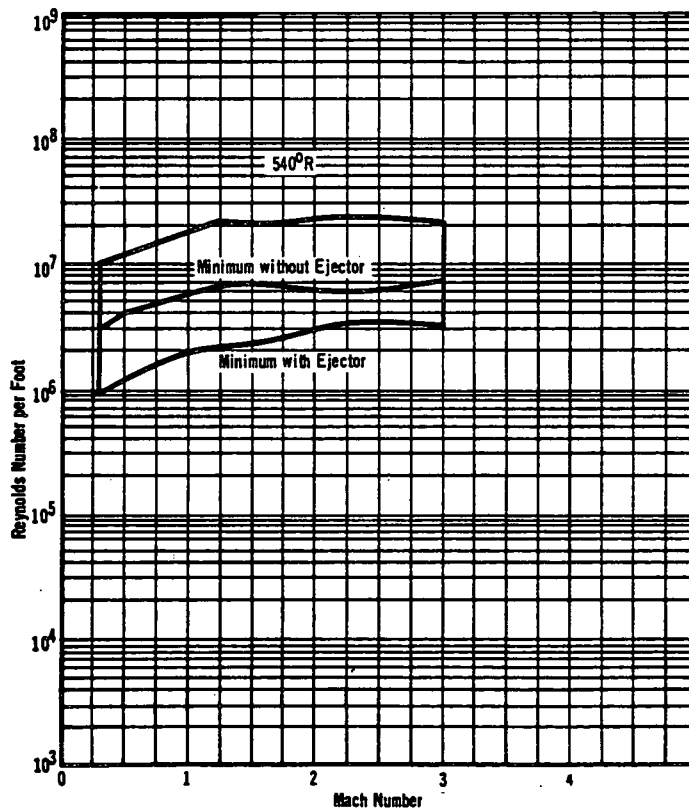
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$4,000	CONSTRUCTION YEAR: 1965 COST \$1,100,000 ESTIMATED REPLACEMENT VALUE \$1,860,000
CONTRACTOR: Nooter Corporation IMPROVEMENTS AND COSTS: (1966-68) Addition of M = 1.7; 2.4; 2.5 Nozzle blocks, Cost \$70,000; (1967) Automatic model positioning, Cost \$15,000; (1967) Automatic Mach sweep, Cost \$10,000; (1968) IBM data acquisition and processing system, Cost \$5,200/month rental.	LOCATION: St. Louis, Missouri

PLANS FOR FACILITY IMPROVEMENTS: Computer controlled model support system - complete in 1971;
Install a universal base end testing capability - complete in 1971.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.3 to 3
Reynolds Number (x 10 ⁶ /ft):	1 to 23
Total Pressure (psia):	8 to 150
Dynamic Pressure (psf):	100 to 4000
Total Temperature (°R):	530
Run Time (sec):	3 to 50

NORTH AMERICAN ROCKWELL/LOS ANGELES 7-FOOT TRISONIC WIND TUNNEL

REPORTING INSTALLATION: North American Rockwell Corporation International Airport Los Angeles, California 90009	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Los Angeles Division, Research and Engineering, Department 056
OTHER SOURCES OF INFORMATION: User's Manual for the North American Rockwell Trisonic Wind Tunnel, Report No. NA-60-764	LOCAL OFFICE TO CONTACT FOR INFORMATION: Wind Tunnel Programs and Testing 5701 W. Imperial Hwy, Los Angeles, Calif. Phone: (213) 670-9151, ext 3421

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The TWT tunnel is an intermittent blowdown to atmosphere type facility with permanently installed tandem test sections capable of testing at subsonic, transonic, and supersonic Mach numbers with a single model installation. Supply pressure for the tunnel is obtained from a 214,000 cu ft storage supply maintained at 147 psia. Flexible plates allow for changes in nozzle contour to produce variations in supersonic Mach number in the upstream test section. A variable diffuser, downstream of the porous wall (19.7%) area, may be adjusted to provide subsonic and transonic Mach number control. The tandem test sections are 7' x 7' x 23'.

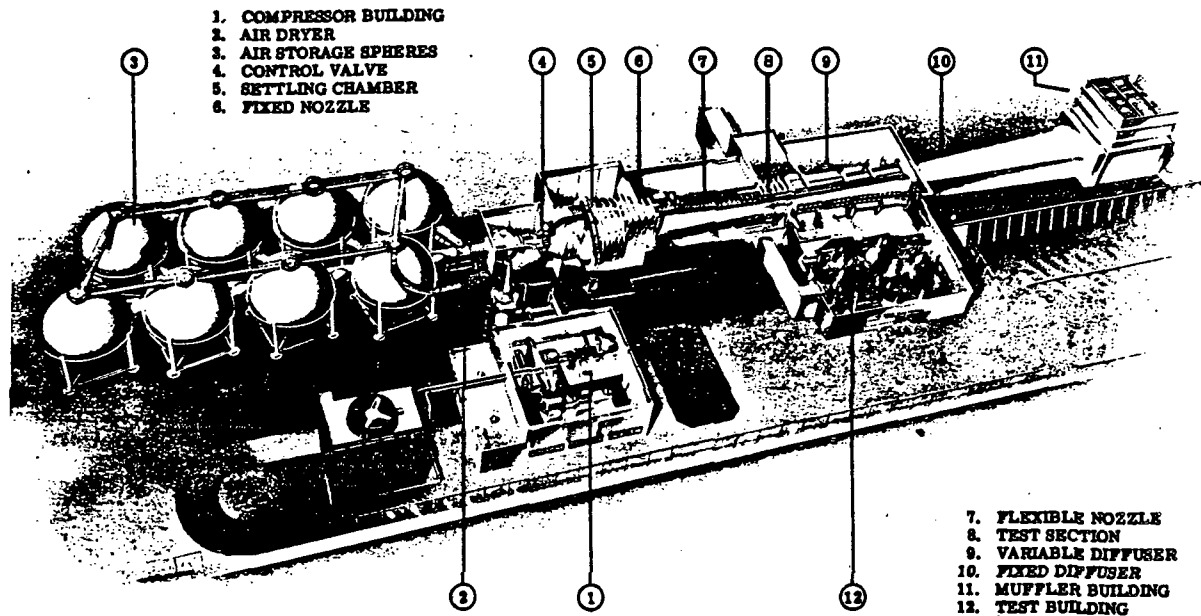
TESTING CAPABILITIES: The TWT facility is fully equipped to perform internal flow and nozzle studies, boundary layer control, store ejection, flutter, dynamic stability, flow visualization (schlieren, oil flow, etc.) and a variety of unusual and special purpose tests, as well as conventional force and pressure studies. The basic support system consists of a remotely driven sector mounted to a movable carriage which may be longitudinally traversed to position a sting mounted model in either test section. The sector support system is capable of pitching the model through an angle of attack range of 15° to +31° at rates from .3° to 3.0° per second using either a pitch-pause or continuous-sweep method to obtain data. A semispan, reflection plane mounting system utilizing an external balance is available for mounting in the transonic test section. Data are recorded with a 120 channel Astrodata (Model 4035-100) low level digital system and reduced on an IBM 1802 on site computer.

FACILITY COST HISTORY

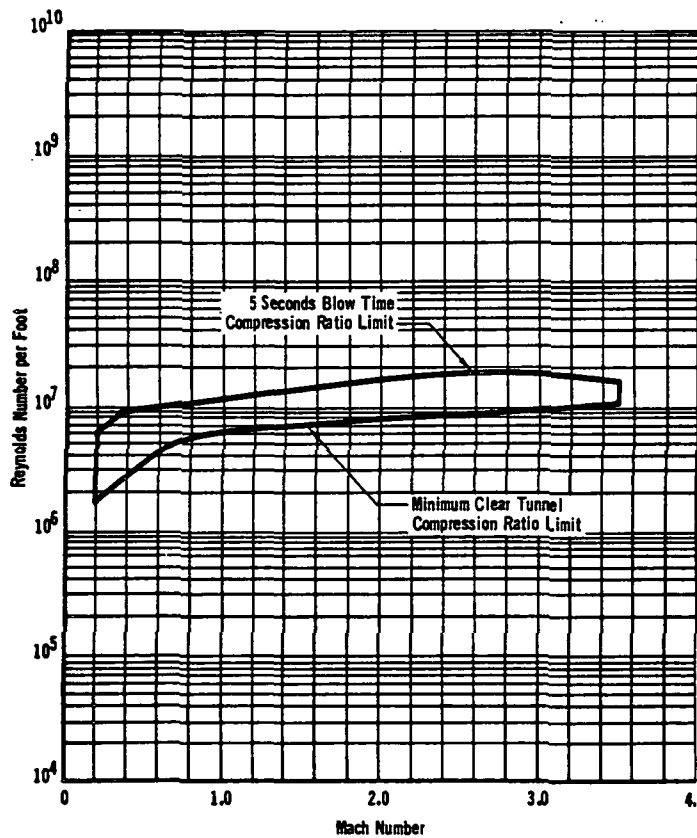
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1958 COST \$ 6,000,000 ESTIMATED REPLACEMENT VALUE \$10,000,000
CONTRACTOR: Pittsburgh - Des Moines Co.	LOCATION: Pittsburgh, Pennsylvania
IMPROVEMENTS AND COSTS: (1960) Install honeycomb in settling chamber; (1967) Astrodata automatic data acquisition system, Cost \$176,000; (1968) IBM 1802, Cost \$4,400 per month.	

PLANS FOR FACILITY IMPROVEMENTS: (1970) Secondary Air System, 3000 psi blowdown; Automatic Transonic Mach Number Control

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.1 to 3.5
Reynolds Number ($\times 10^6/\text{ft}$):	2 to 17
Total Pressure (psia):	20 to 110
Dynamic Pressure (psf):	100 to 3100
Total Temperature ($^{\circ}\text{R}$):	530
Run Time (seconds):	5 to 70
Pump Time (minutes):	20 to 30

NORTHROP 24-INCH TRISONIC WIND TUNNEL

REPORTING INSTALLATION Northrop Corporation Aircraft Division 3901 W. Broadway Hawthorne, California 90250	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (213) 675-4611, ext 2554

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The high speed test facility consists of two separate wind tunnel circuits transonic and hypersonic operating from a common high pressure storage system. The trisonic circuit covers the testing range of Mach .2 through 1.35, 1.5, 2.0, and 3.0. Both tunnels are of the intermittent blowdown type using interchangeable nozzles. The trisonic tunnel has a 2 by 2 foot test section. For transonic operation, a transonic nozzle, perforated test section (10 percent porous with slotted holes 1/8-inch wide and 1-inch long), and a constant diameter diffuser are utilized to obtain a range of Mach numbers from .2 to 1.35. Supersonic operation at Mach numbers of 1.5, 2, and 3 is accomplished with the supersonic nozzles, supersonic test section, and variable geometry diffuser. A perforated plate consisting of an array of venturis, a honeycomb assembly, and a wire mesh are used to reduce upstream turbulence before the air enters the 90-inch diameter settling chamber. Downstream of the settling chamber is a bellmouth assembly providing a nearly axisymmetric three-dimensional to two-dimensional contraction. The bellmouth is compatible with all of the nozzles of the trisonic circuit. Choking flaps are provided downstream of the support system to establish subsonic flow in the transonic nozzle. Tunnel air is exhausted either to the atmosphere or to a 100,000 ft³ vacuum sphere depending on test requirements. During atmospheric discharge the flow is exhausted through a muffler housed in a reinforced concrete structure which forces the flow upward through a series of acoustical baffles.

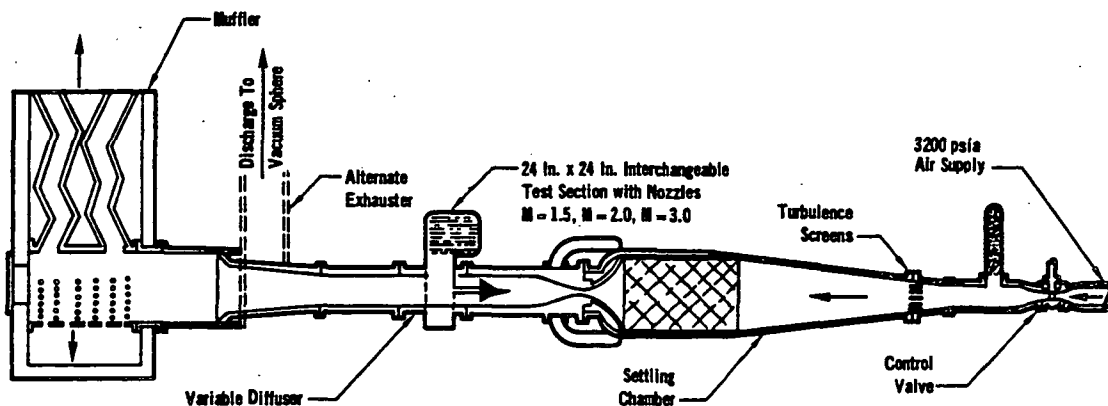
TESTING CAPABILITIES: The support system was designed to be installed and utilized in the trisonic tunnel circuit as well as in a closed jet circuit of the hypersonic wind tunnel. A minimum of installation and calibration time is involved in moving from one circuit to another. The system is basically a pitch and pause type which is controlled by the data acquisition equipment. Unique features include twenty preset model positions with a variable pause time (.01 to 1.0 second) and variable rate between positions (5 to 20 degrees per second). The system consists of a vertically translating strut with a sting mounting pod pivoting about a fixed location on the strut. Pitch capability of ± 20 degrees, a roll range of 360 degrees, and a change in the pitch center of rotation through a range of 15 inches are attainable. A mechanical linkage between pod rotation and strut translation is variable in ratio to provide the variable model center of rotation. This variable ratio is provided by guiding the strut in roller bearings and controlling pod pitch angle with a parallelogram type linkage. The model support system is computer controlled and may be operated in either the automatic or manual mode. With the system in either mode of operation, emergency home may be commanded to return the model to a preset condition. Data are recorded on a high speed Central Data Acquisition System which is coupled to a Honeywell DDP 516 Computer. The data processing equipment is capable of providing on-line reduced data and plots. A total of 100 channels are available.

FACILITY COST HISTORY

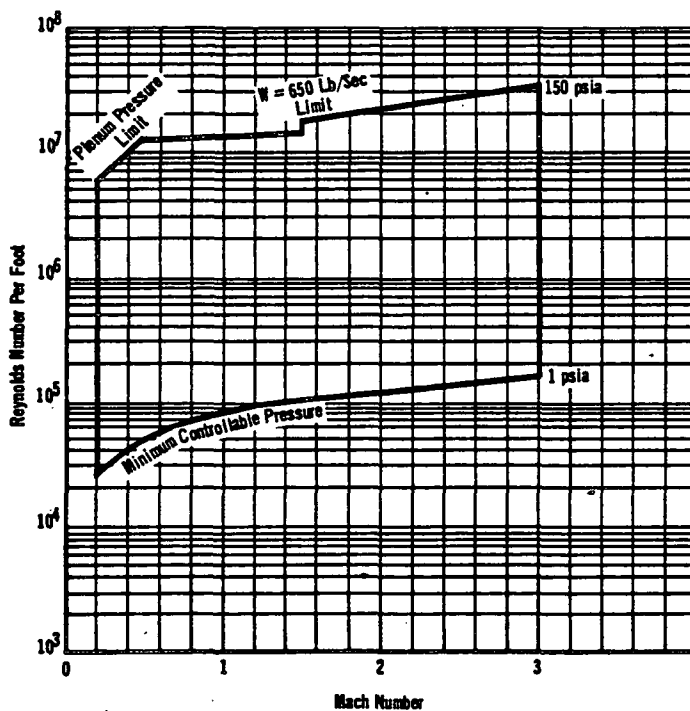
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: (Not Available)	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.2 to 1.35, 1.5, 2, 3
Reynolds Number ($\times 10^6/\text{ft}$):	.15 to 70
Total Pressure (psia):	0 to 600
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	Not Available
Run Time (seconds):	25
Pump Time (minutes):	Not Available

NSRDC 18-INCH BY 18-INCH SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Naval Ship Research and Development Center Department of Aerodynamics, Code 681 Washington, D.C. 20007	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Engineering and Facilities Division, Code 680
OTHER SOURCES OF INFORMATION: Aero Reports 1027; 1070	LOCAL OFFICE TO CONTACT FOR INFORMATION: Facilities Branch Code 681 Phone: (301) 995-3147

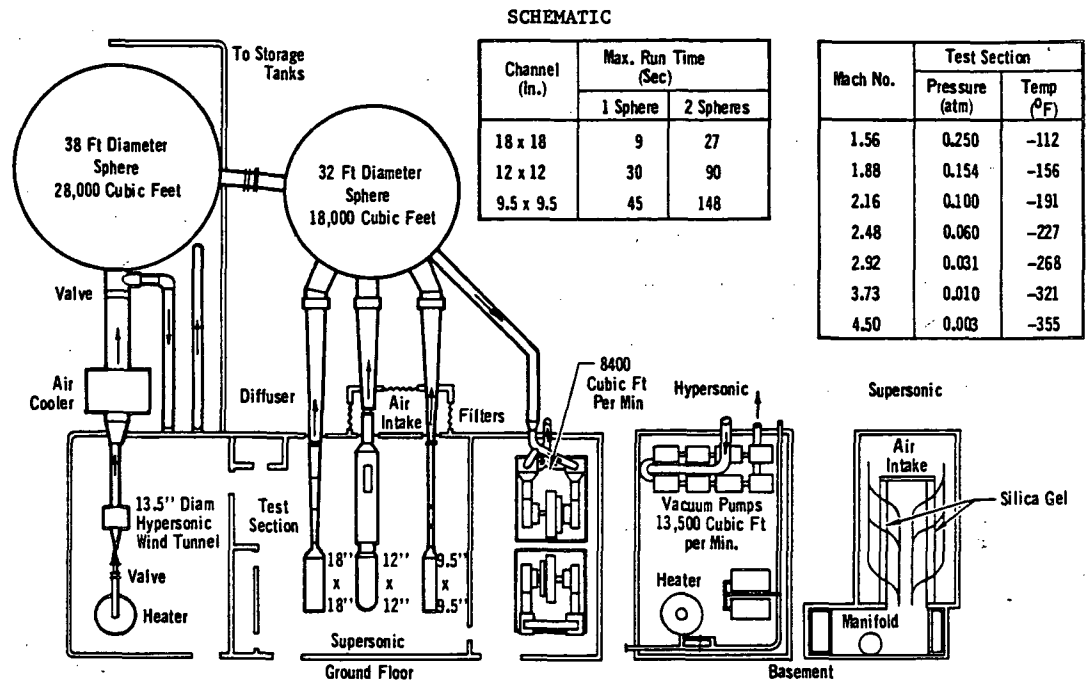
FACILITY DESCRIPTION: This facility is a supersonic intermittent flow blowdown type wind tunnel which has an 18 by 18 by 24 inch test section. The tunnel uses dried air, stored at atmospheric pressure which exhausts to two evacuated spheres. Subsonic speeds are attained by using a set of subsonic nozzles and varying the opening of the tunnel operating butterfly valve. Supersonic Mach numbers are varied by the installation of a different set of laval nozzle blocks for each Mach number desired. The vacuum field capacity is 47,000 cu ft.

TESTING CAPABILITIES: This facility is capable of force and pressure type tests. A motor driven, variable rate angle of attack sector allows a complete angle sweep to be obtained during one run. A pressure survey system is installed downstream of the test section. This system can be equipped with a remotely controlled total or static pressure probe which can be moved to measure the pressure distribution throughout the flow field. This mechanism can also be used to hold a balance-mounted bomb or missile being tested in conjunction with an airplane mounted conventionally in the tunnel. Various instrumentation, strain gage balances, a schlieren system and a high speed 50 channel Beckman 210 data acquisition system are available for use with this tunnel. Data are reduced on site with an SDS 390 digital computer.

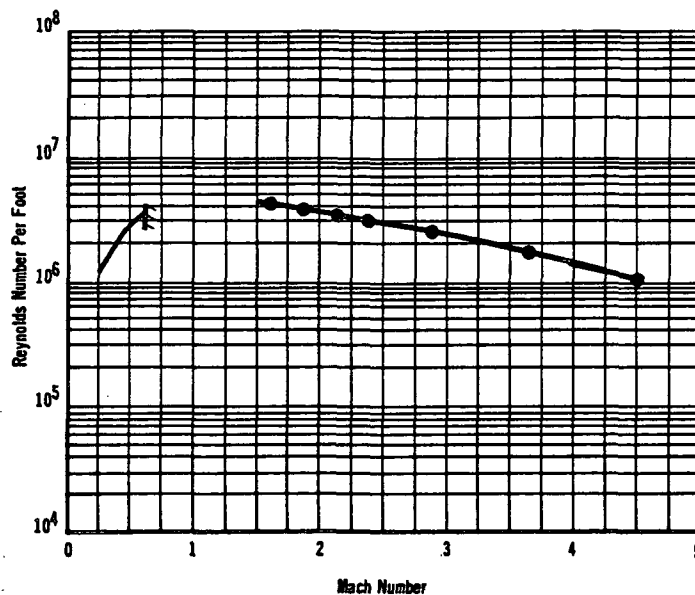
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$600	CONSTRUCTION YEAR: 1950 COST \$170,000 ESTIMATED REPLACEMENT VALUE \$330,000
CONTRACTOR: IMPROVEMENTS AND COSTS:	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None



FACILITY PERFORMANCE DATA



Mach Range: .2 to .9 and 1.56 to 4.5

Reynolds Number (x 10⁶/ft): 1 to 5

Total Pressure (psia): Atmospheric

Dynamic Pressure (psf): 58 to 805

Total Temperature (°R): Ambient

Run Time (seconds): 26

Pump Time (minutes): 12 (vacuum)

NSRDC 7-FOOT BY 10-FOOT TRANSONIC WIND TUNNEL

REPORTING INSTALLATION: Naval Ship Research and Development Center Department of Aerodynamics, Code 681 Washington, D.C. 20007	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Engineering and Facilities Division, Code 680
OTHER SOURCES OF INFORMATION: Aero Reports 1070; 985	LOCAL OFFICE TO CONTACT FOR INFORMATION: Facilities Branch Code 681 Phone: (301) 995-3147

DESCRIPTION AND TESTING CAPABILITIES

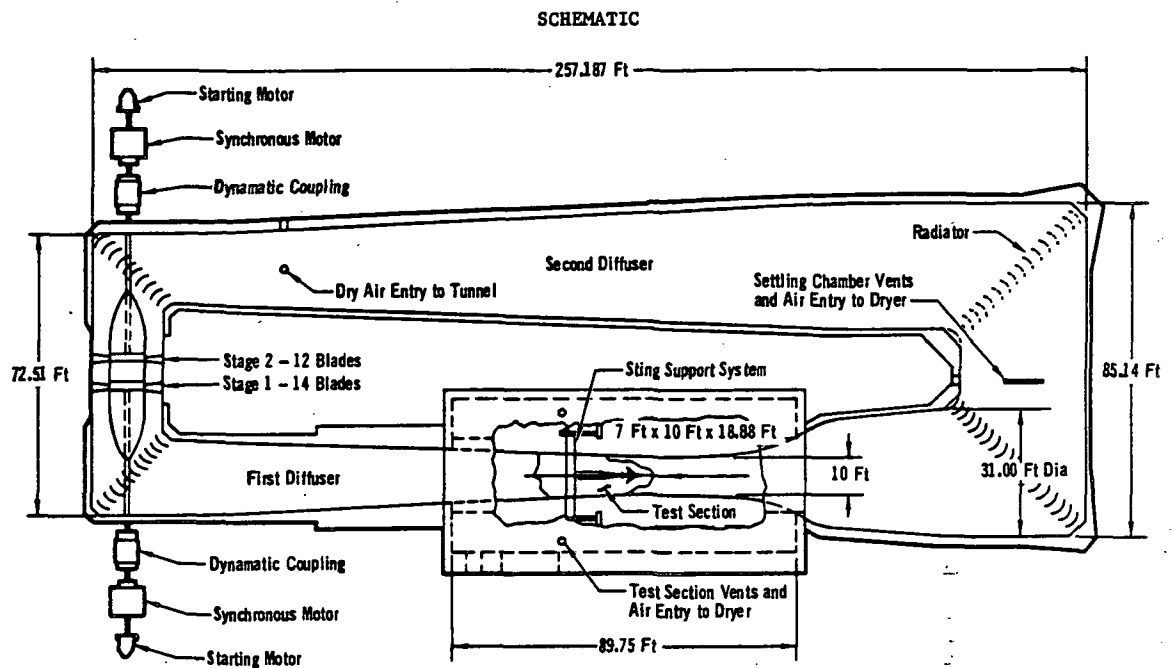
FACILITY DESCRIPTION: This tunnel is a closed circuit, single-return and continuous flow type with a test section 7 feet high, 10 feet wide, and 19 feet long and a contraction ratio of 14.5. The test section, which is enclosed in a pressure-tight chamber, has slots in the floor and ceiling which control the expansion of the air in the test section and permit transonic testing. Air dryers are used to maintain condensation free flow, while a finned-tube radiator and cooling tower are used to control stagnation temperature. Evacuation pumps provide a range of test stagnation pressures. The main drive produces 24,000 hp at 720 rpm.

TESTING CAPABILITIES: This facility is capable of force and moment, pressure, store separation, dynamic stability, two dimensional airfoil, boundary layer control, aerodynamic flutter, buffet studies, point prediction and grid techniques for determining separation trajectories, and five gang 48 port scanivalve system for pressure test can all be tested at this facility. This tunnel has a main sting-type, support system consisting of a cantilevered boom mounted on a vertical strut which provides remote position of a model in three degrees of freedom. A sting-type missile support system with six remotely controlled degrees of freedom permits the testing of a missile or store in proximity to the parent aircraft-allowing store/separation and trajectory prediction tests to be performed. A wide variety of strain gage balances are available for force testing, including a dynamic stability balance which obtains data in the forced oscillation mode of operation. A two-dimensional airfoil testing system is also available for use. A 1/12 scale model tunnel of the tunnel is also available for testing purposes. Windows are provided in the test section sidewalls to permit model observation (visual and/or TV) and photography along with the use of a schlieren system. A 2 lb/sec, 200 psi auxiliary air supply is available. Data are recorded using 50 channels on a Beckman 210 and reduced on site with an SDS 390 digital computer.

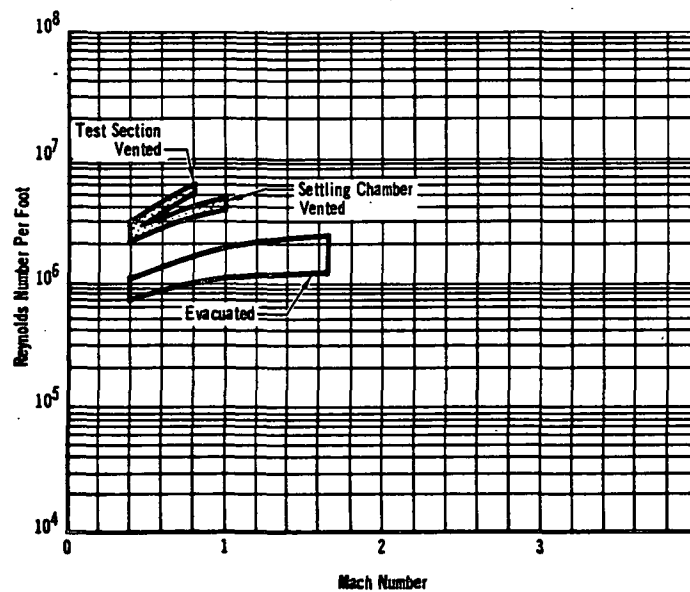
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$3600	CONSTRUCTION YEAR: 1956 COST \$5,000,000 ESTIMATED REPLACEMENT VALUE \$8,600,000
CONTRACTOR: IMPROVEMENTS AND COSTS:	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: Extend the Mach number to 1.40, in the formulation stage.



FACILITY PERFORMANCE DATA



Mach Range: .4 to 1.17
 Reynolds Number ($\times 10^6/\text{ft}$): 1 to 6
 Total Pressure (psia): 3.68 to 25.6
 Dynamic Pressure (psf): 50 to 950
 Total Temperature ($^{\circ}\text{R}$): 610
 Run Time: Continuous

UNITED AIRCRAFT 8-FOOT SUBSONIC/TRANSONIC WIND TUNNEL

REPORTING INSTALLATION United Aircraft Research Laboratories Silver Lane East Hartford, Connecticut 06108	STATUS OF FACILITY: <u>Active</u> COGNIZANT ORGANIZATIONAL COMPONENT: United Aircraft Research Laboratories, Test Facilities
OTHER SOURCES OF INFORMATION: Facility Handbook	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Test Facilities, United Aircraft Research Laboratories Phone: (203) 565-6268

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an atmospheric, continuous flow, closed circuit, single return wind tunnel. It was originally a low speed facility with interchangeable octagonal 8-foot and 18-foot test sections. The tunnel was modified in 1968 for transonic testing. The 8-foot slotted section is now placed within the 18-foot section which provides a plenum chamber for the 8-foot section. An auxiliary air removal system with associated ducting has been installed to relieve the mainstream power requirements by removing flow from the slotted test section (0 to 14.6% slotted).

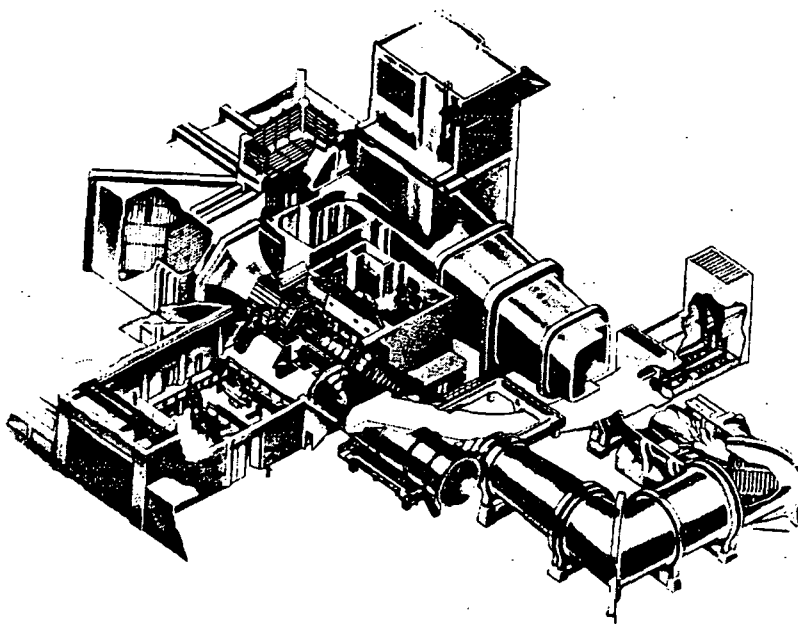
TESTING CAPABILITIES: The tunnel is used for testing model propellers, helicopters, airplanes, missiles, and their components. Many types of supports are available and additional supports are designed and constructed for special tests as required. An auxiliary air supply is available (10 lb/sec and 400 psi). A schlieren system is available for flow visualization. Data are recorded with an in-house design-static system capable of 280 readings per point with 25 channels, and reduced with an on site PDP-6, time sharing system.

FACILITY COST HISTORY

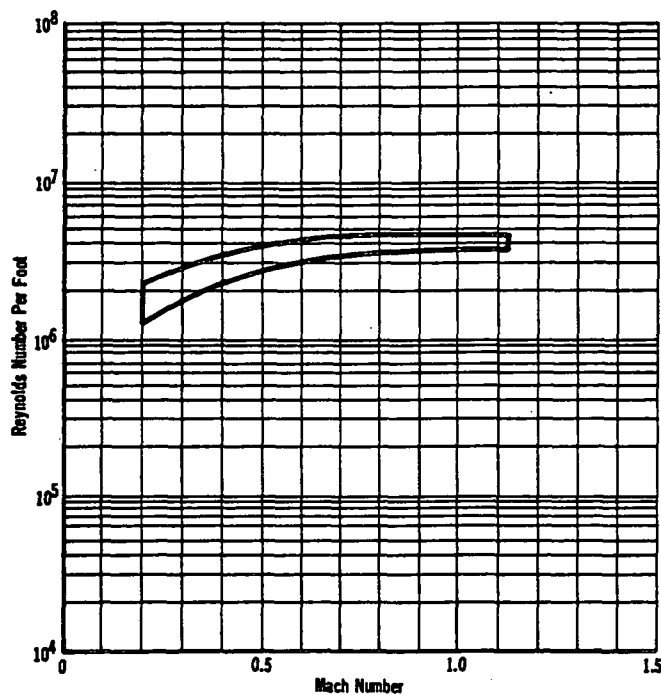
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: (Not Available)	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	0 to 1.17
Reynolds Number (x 10 ⁶ /ft):	1.2 to 4.5
Total Pressure (psia):	Atmospheric
Dynamic Pressure (psf):	0 to 860
Total Temperature (°R):	520 to 610
Run Time:	Continuous

UNITED AIRCRAFT 17-INCH SUPERSONIC WIND TUNNEL

REPORTING INSTALLATION: United Aircraft Research Laboratory East Hartford, Connecticut 06108	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: United Aircraft Research Laboratories, Test Facilities
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Test Facilities Phone: (203) 565-6268

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is a unitary, intermittent blowdown to atmosphere type facility with a 17 by 17 by 17 inch test section. A flexible nozzle is used to provide uniform flow at test section Mach numbers. A heat exchanger is used to maintain the air supply at constant temperatures. Constant total pressure to the tunnel is controlled automatically. This facility is equipped with air storage tanks that have 15,000 cu ft capacity at 400 psia.

TESTING CAPABILITIES: A sector permits the model angle of attack to be changed from -15 to +25 degrees during a run so that the model is pitched about the center of the test section in one of the following modes: (1) constant velocity travel between preselected start and stop angles, (2) step operation between start and stop angles, and (3) manual operation. Inlet test equipment is comprised of ducted force balances and an external airflow control throttle. This equipment permits simultaneous measurement of inlet pressure recovery, airflow and drag. An auxiliary air supply of 10 lb/sec at 400 psia is available. Schlieren and shadowgraph systems are available for flow visualization. Data recording consists of self balancing potentiometers coupled to card punch (100 points per minute) with 25 channels, and reduced on site with a Univac 1108 computer system.

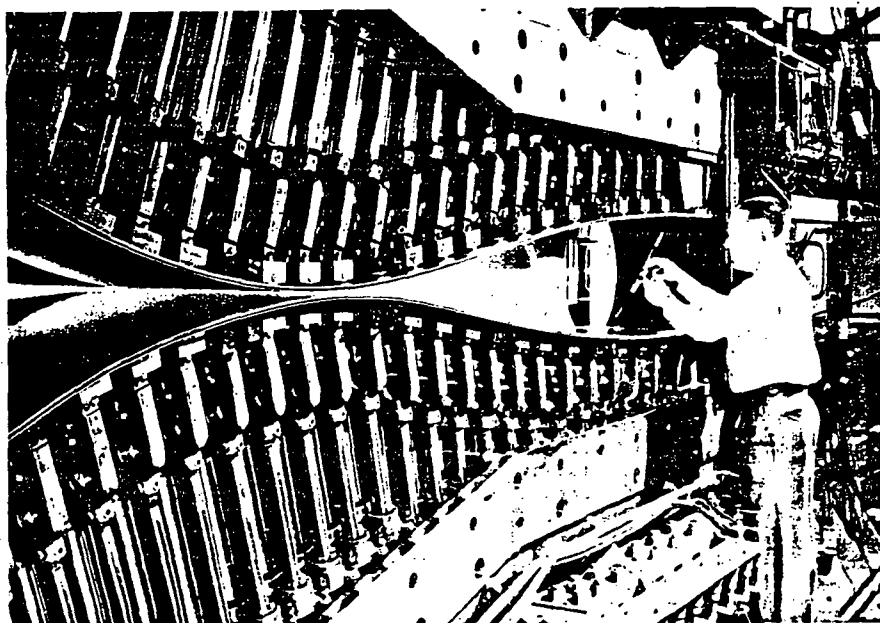
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: (Not Available)	

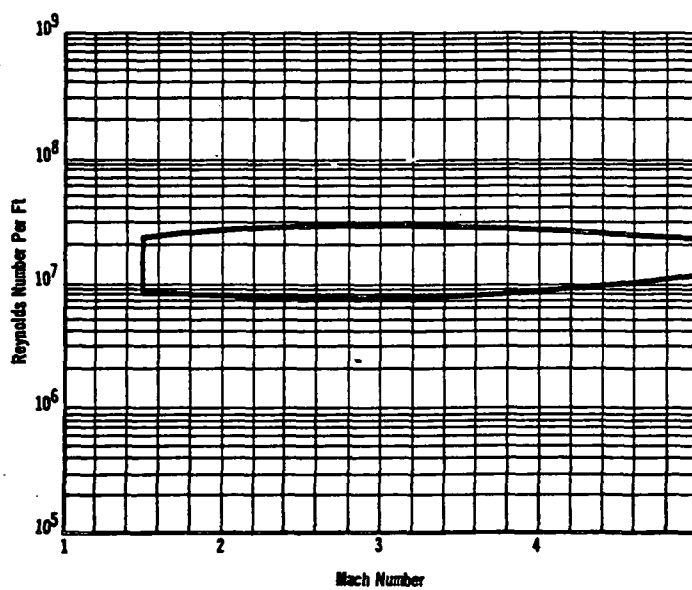
PLANS FOR FACILITY IMPROVEMENTS: None

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SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 1.5 to 5
 Reynolds Number ($\times 10^6/\text{ft}$): 7 to 27.6
 Total Pressure (psia): 41.3 to 309
 Dynamic Pressure (psf): 1000 to 7500
 Total Temperature ($^{\circ}\text{R}$): 550
 Run Time (seconds): 20 to 90
 Pump Time (minutes):

UNITED AIRCRAFT 17-INCH TRANSONIC WIND TUNNEL

REPORTING INSTALLATION: United Aircraft Research Laboratory East Hartford, Connecticut 06108	STATUS OF FACILITY: <u>Active</u> COGNIZANT ORGANIZATIONAL COMPONENT: United Aircraft Research Laboratories, Test Facilities
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Test Facilities Phone: (203) 565-6268

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is an intermittent blowdown to atmospheric type facility. The test section is 17 by 17 by 18 inches with 22% perforated walls. The tunnel operates over a Mach range of .4 to 1.4 and with the additional installation of fixed solid walls and nozzle blocks may be run at Mach numbers of 1.5, 2.0, and 2.5. A heat exchanger is used to maintain the air supply at constant temperatures. This facility is equipped with air storage tanks that have 15,000 cu ft capacity at 400 psia.

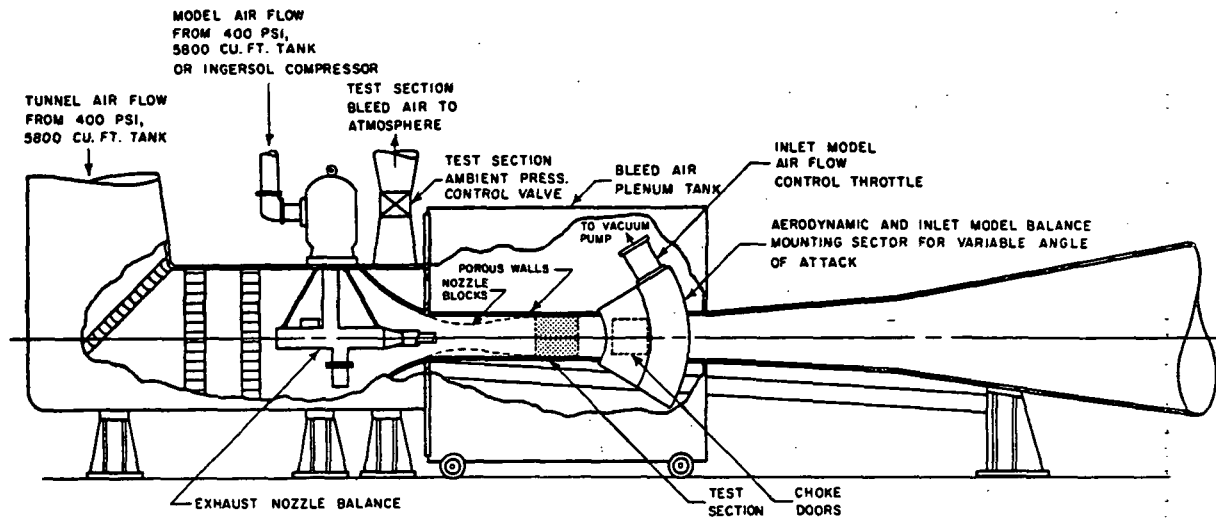
TESTING CAPABILITIES: A sector permits the model angle of attack to be changed from -15 to +25 degrees during a run so that the model is pitched about the center of the test section in one of the following modes: (1) constant velocity travel between preselected start and stop angles, (2) stop operation between start and stop angles, and (3) manual operation. Inlet test equipment is comprised of ducted force balances and an external airflow control throttle. This equipment permits simultaneous measurement of inlet pressure recovery, airflow, and drag. An auxiliary air supply of 10 lb/sec at 400 psia is available. Schlieren and shadowgraph systems are available for flow visualization. Data recording consists of self balancing potentiometers coupled to card punch (100 points per minute) with 25 channels, and reduced on site with a Univac 1108 computer system.

FACILITY COST HISTORY

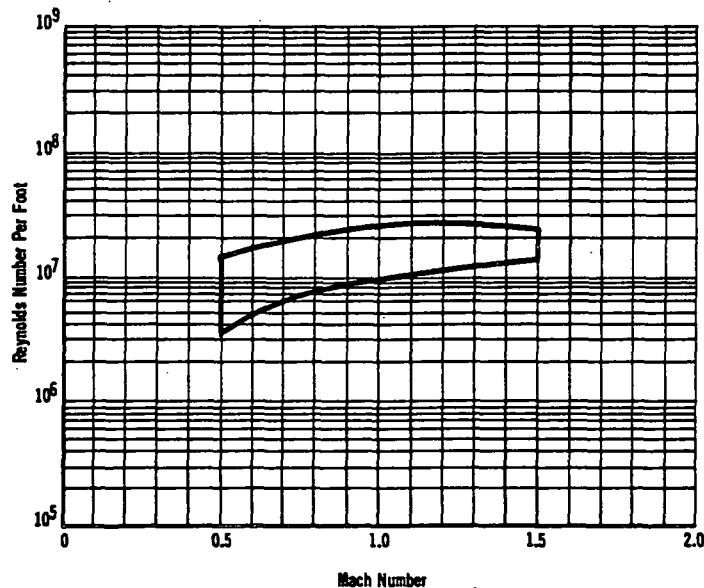
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: (Not Available)	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHMATIC



FACILITY PERFORMANCE DATA



Mach Range:	.5 to 1.4 and 1.5, 2, 2.5
Reynolds Number ($\times 10^6/\text{ft}$):	3.5 to 22.8
Total Pressure (psia):	25 to 75
Dynamic Pressure (psf):	400 to 4500
Total Temperature ($^{\circ}\text{R}$):	540
Run Time (seconds):	10 to 15
Pump Time (minutes):	40

C.3. HYPERSONIC WIND TUNNELS

AEDC HYPERSONIC WIND TUNNELS

REPORTING INSTALLATION: Arnold Engineering Development Center (AEDC) Arnold Air Force Station, Tennessee 37389	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Air Force Systems Command
OTHER SOURCES OF INFORMATION: Test Facilities Handbook, AEDC 8th Edition, December 1969	LOCAL OFFICE TO CONTACT FOR INFORMATION: Director of Test (AET) Phone: (615) 455-2611, ext 625 or 645

INFORMATION ON THE FOLLOWING FACILITIES:

Hypersonic Wind Tunnels (B, C, and E)
Hypervelocity Wind Tunnels (F and H)
Hypervelocity Research Tunnels (I, J, and L)
Low Density Hypersonic Wind Tunnel (M)

IS SUBJECT TO SPECIAL EXPORT CONTROLS. FURTHER INFORMATION MAY BE OBTAINED FROM:

Air Force Systems Command
Arnold Engineering Development Center
Arnold Air Force Station, Tennessee 37389

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AEROSPACE CORPORATION HELIUM DRIVEN SHOCK TUNNEL

REPORTING INSTALLATION: Aerospace Corporation 2350 East El Segundo Boulevard El Segundo, California 90245	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aerodynamics and Propulsion Research Laboratory
OTHER SOURCES OF INFORMATION: Design and Calibration of a Mach 20 Nozzle for the Hypersonic Shock Tunnel Aerospace No. TOR-0158(3240-10)-4 March 1968	LOCAL OFFICE TO CONTACT FOR INFORMATION: R. L. Varwig, Manager Aerodynamic Facilities Phone: (213) 648-7387

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is a helium driven shock tunnel. The diameter of the Mach 20 contoured nozzle at its exit is 47 inches. At the conditions of 2000°K, 200 atm, the uniform flow core is 16 inches in diameter. The facility has been used satisfactorily at off-design reservoir temperature from 1500 to 2700°K at reservoir pressures from 50 to 500 atm. Steady reservoir conditions of 10 to 12 milliseconds are obtained. The test medium is air or nitrogen and the drive medium is helium. The test gas volume is 1.0 cu ft at 112 psia and the driver gas volume is 1.0 cu ft at 10,000 psia.

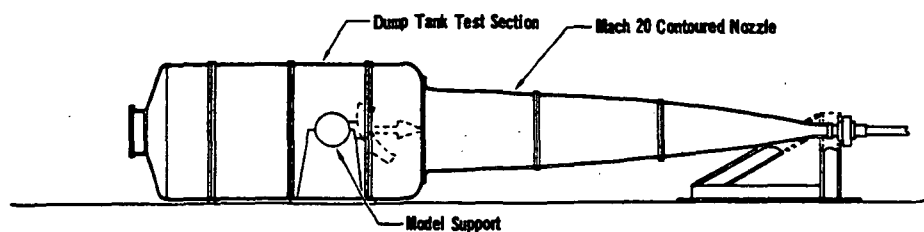
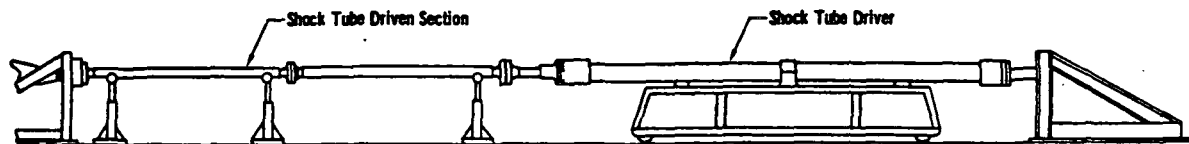
TESTING CAPABILITIES: This tunnel is capable of pressure, heat transfer and force balance instrumentation for a variety of testing. The tunnel is currently being employed to study boundary layer transition and turbulence using hot wire and film techniques to observe flow fluctuations. The facility can accommodate models up to 2 feet in length on its angle-of-attack sting for a range of attack angle from -10° to +30°. For shorter models, maximum angle of attack is 60°. Cathode ray oscilloscopes provide the most flexible recording equipment, however, a 14 channel tape recorder with maximum frequency response of 1.5 MHz in direct mode is also available. This instrument makes it possible to reduce data obtained in a test in terms of frequency spectrum, through various type analog circuits or at a wide range of speeds. An Ampex FR1800H (14 channels) and Tektronix 535A 551 CROs (20 channels) recording system is available. An off site CDC 6400 (plus peripheral equipment) are used for reducing data. This facility is capable of completing two runs per day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$320 (manpower only)	CONSTRUCTION YEAR: 1959-61 COST \$ 57,000 ESTIMATED REPLACEMENT VALUE \$200,000†
CONTRACTOR: The Aerospace Corporation	LOCATION: El Segundo, California
IMPROVEMENTS AND COSTS:* (1963) Added combustion driver, New nozzle, Model support, Cost \$43,800; (1966) Contoured nozzle and installation, Cost \$30,000; (1968) Second compressor (to handle more gas), Cost \$10,000; Electronic equipment purchased over the past 10 years, Cost \$69,000.	
* Costs do not include building or land.	
† Replacement costs are less than total which included components which have been superseded.	

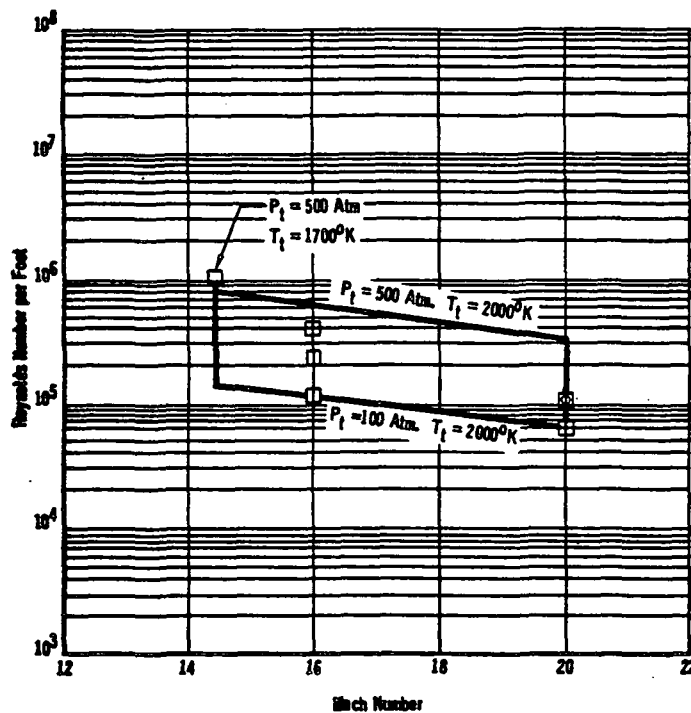
PLANS FOR FACILITY IMPROVEMENTS: None at present.

SCHMATIC



Scale: 1/40

FACILITY PERFORMANCE DATA



Mach Range:	14 to 20
Reynolds Number ($\times 10^6/\text{ft}$):	.1 to 1.2
Total Pressure (psia):	750 to 7500
Dynamic Pressure (psf):	8 to 302
Total Temperature ($^\circ\text{R}$):	2700 to 5000
Run Time (milliseconds):	10 to 12

Design point - $P_t = 200 \text{ Atm}$, $T_t = 2000^\circ\text{K}$
Regular test conditions

AFAPL RAMJET RESEARCH 10-FOOT SHOCK TUNNEL

REPORTING INSTALLATION: Air Force Aero Propulsion Laboratory AFAPL/APMD Wright-Patterson AFB, Ohio 45433	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Technical Facilities Division, AF Aero Propulsion Laboratory
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: AFAPL/APMD, Wright-Patterson AFB Phone: (516) 255-4430

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a shock tunnel for hypersonic engine development and research. It consists of a six inch driven tube connected to a variable Mach number nozzle. The test rhombus is a nominal 40 inches in diameter. Total pressures up to 14,000 psia can be obtained with a stagnation temperature of 5700°R.

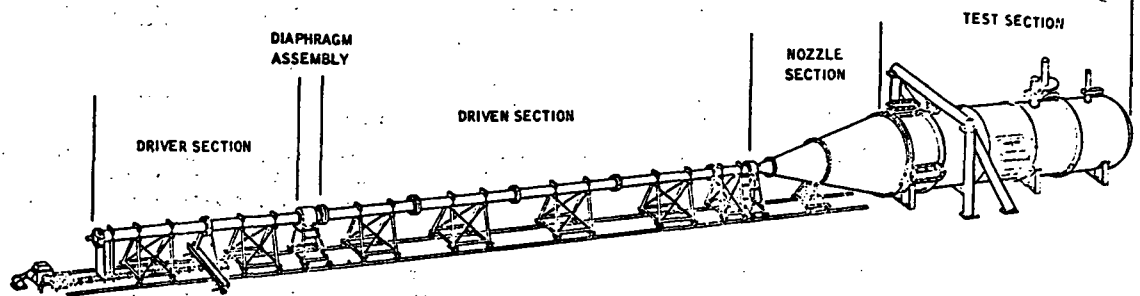
TESTING CAPABILITIES: This tunnel is capable of hypersonic engine development and research. Instrumentation for pressure, heat transfer, and flow visualization are available. Data are recorded with an SRL digital computer on magnetic tape using 64 channels. This facility is capable of two runs per day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$640	CONSTRUCTION YEAR: 1968 COST \$1,854,750 ESTIMATED REPLACEMENT VALUE \$2,934,600
CONTRACTOR: Avco Corporation	LOCATION: Wilmington, Massachusetts
IMPROVEMENTS AND COSTS: (1968) Building modification, Cost \$281,000.	

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



FACILITY PERFORMANCE DATA

Operating Envelope

(Not Available)

Mach Range:	8 to 33
Reynolds Number ($\times 10^6/\text{ft}$):	1 nominal
Total Pressure (psia):	14,000
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	5700
Run Time (milliseconds):	10

AFFDL 50-MEGAWATT GASDYNAMIC FACILITY

REPORTING INSTALLATION: Air Force Flight Dynamics Laboratory (FDMF) Wright-Patterson AFB, Ohio 45433	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: FDME Branch
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Director AFFDL Attn: Asst. for System Support (FDS), WPAFB Phone: (513) 255-5424

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The main test leg is a continuous flow, arc heated, hypersonic tunnel. Air at high pressure is heated by a direct current arc and then expanded through a nozzle to hypersonic velocities. A combination steam ejector-mechanical pump system is used to exhaust the flow to atmosphere. The maximum run time is about 30 minutes. A conical nozzle system of 8° half angle and exit diameters 2, 3.5, 5, 6.5, and 8 feet is available. Nozzles exhaust into an open jet test section. The test core diameter varies from 1.5 to 5.5 feet. The Reentry Nose Tip (RENT) leg, produces a high pressure, high enthalpy, low Mach number free air jet in an open atmospheric test section. Three types of test flow nozzles are available: contoured, conical and flared. All nozzles have a throat diameter of .9 inch, while the exit diameter varies from 1.11 to 4.5 inches. This facility is capable of 2 runs per day.

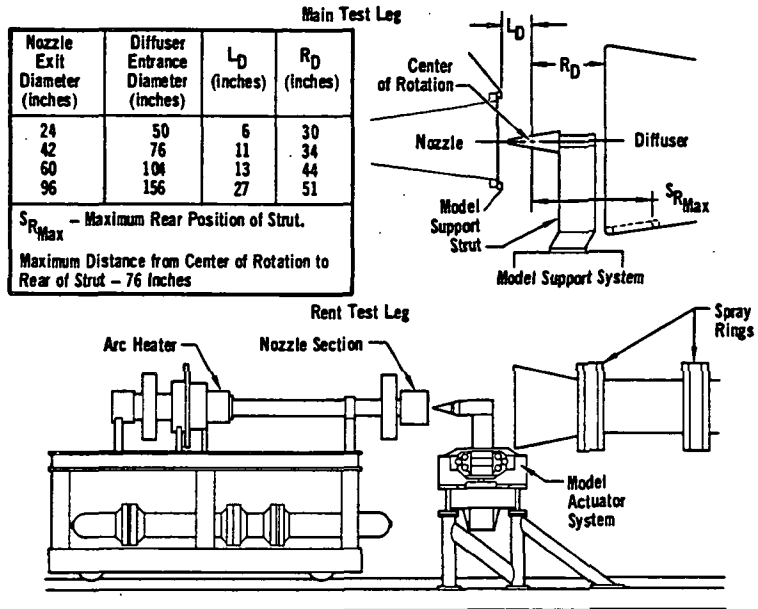
TESTING CAPABILITIES: This facility is used to conduct exploratory studies of reentry heating and advanced development of aerothermal structures and thermal protection systems. In the main test leg the models are supported in the free jet on a strut-carriage system with pitch and roll capability. They can be cooled by a multi-loop variable pressure water system. Probes for measuring pitot pressure, mass flux, stagnation point heat flux, and total enthalpy are available to record flow conditions. The data acquisition system is built around an Ambilog 200 stored program hybrid computer (on site). The RENT test leg is used to investigate aerodynamic heating conditions of missile nose tips during reentry flight. A maximum of 5 models can be supported by the available carriage system and injected individually into the flow. Nose cone tips with radius .25 to .50 inches are tested. The data acquisition system is the same system used for the main test leg.

FACILITY COST HISTORY

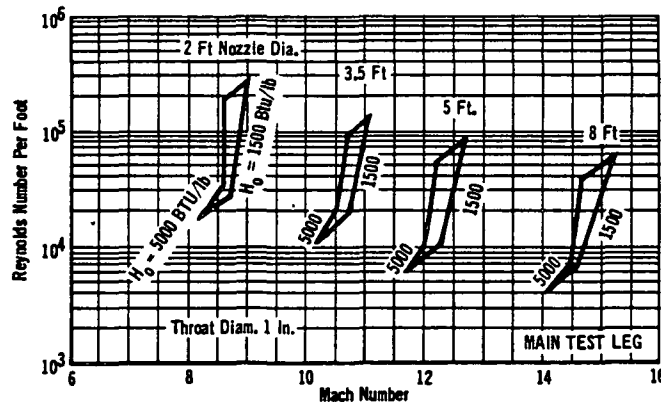
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	\$10,000-Main Test Leg \$5000 - RENT Test Leg	CONSTRUCTION YEAR: 1963-69	COST \$17,000,000
CONTRACTOR:	Blount Brothers, Inc.	ESTIMATED REPLACEMENT VALUE	\$21,000,000
IMPROVEMENTS AND COSTS:	(1969) Addition of Reentry Nose Tip test leg, Cost \$200,000; (1970) Addition of stored air supply, 1500 cu ft at 6000 psi, Cost \$250,000.		

PLANS FOR FACILITY IMPROVEMENTS: Servo-controlled axial model drive system (for 5 individual nose tip models); higher power, higher pressure arc heater.

SCHMATIC



FACILITY PERFORMANCE DATA



Main Test Leg

Mach Range: 5.5 to 15

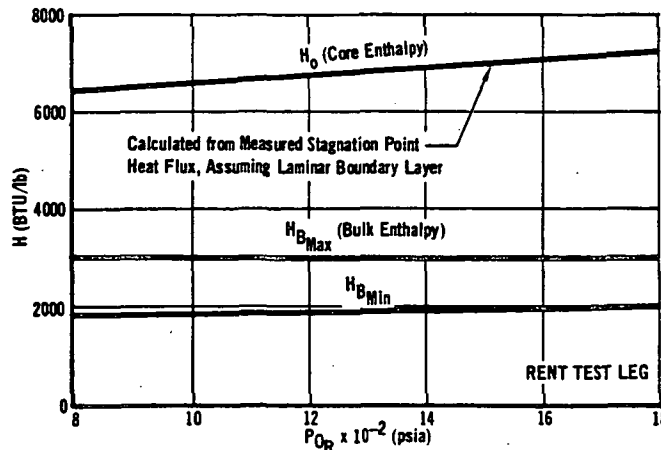
Reynolds Number ($\times 10^6/\text{ft}$): .004 to .3

Total Pressure (psia): 50 to 1750

Dynamic Pressure (psf): 7 to 400

Total Temperature ($^{\circ}\text{R}$): 6500 to 11,300

Run Time (minutes): 30 maximum



RENT Test Leg

Mach Range: 1.8 to 4.0

Reynolds Number ($\times 10^6/\text{ft}$)

a) Simulated Flight Conditions: 40 maximum

b) Hot Core Test Flow: 8 maximum

Total Pressure (psia): 800 to 1800

Pitot Pressure (atm): 5 to 100

Total Temperature on Centerline ($^{\circ}\text{R}$): 6300 to 14,000

Run Time (minutes): 2 to 5

AFFDL 2-FOOT ELECTROGASDYNAMIC FACILITY

REPORTING INSTALLATION: Air Force Flight Dynamics Laboratory (FDMG) Wright-Patterson AFB, Ohio 45433	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Flight Mechanics Division (FDM)
OTHER SOURCES OF INFORMATION: Report Number FDM-TM-68-3, July 1968; Paper prepared for 31st semiannual meeting of STA, 24-25 April 1969	LOCAL OFFICE TO CONTACT FOR INFORMATION: High Speed Aeroperformance Branch (FDMG) Phone: (513) 255-5452 or 3061

DESCRIPTION AND TESTING CAPABILITIES

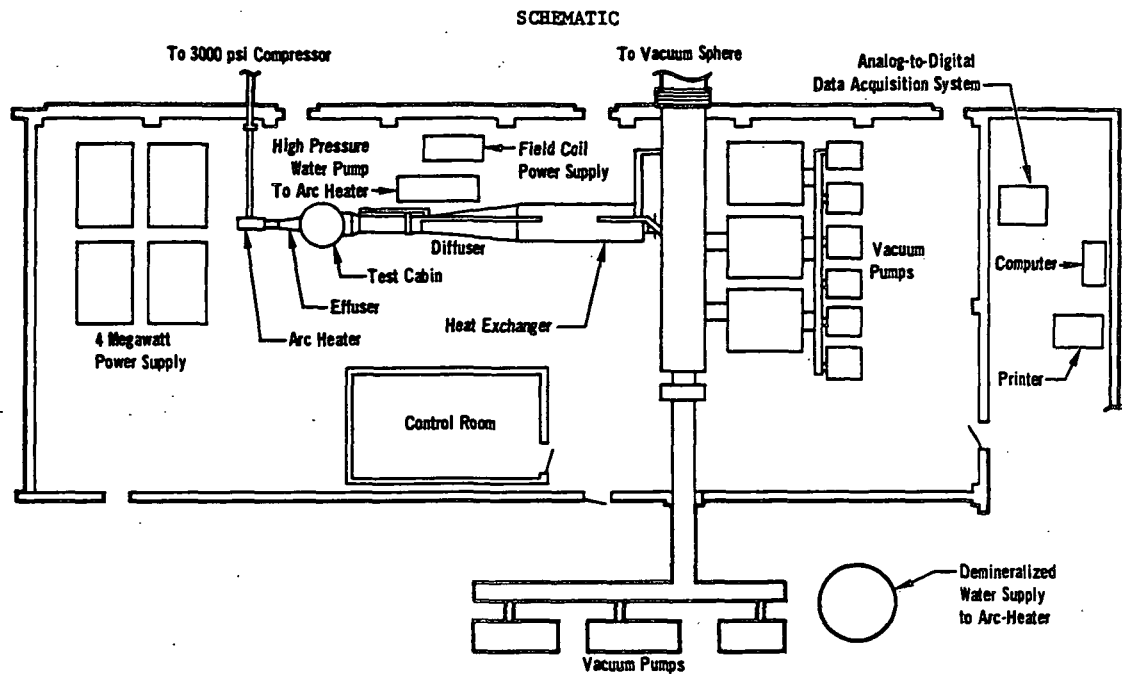
FACILITY DESCRIPTION: The 2-foot EGF is an arc heated hypersonic wind tunnel capable of Mach 6 to 12 operation at bulk enthalpy levels to 7000 Btu/lb. Arc heaters are tubular coaxial electrode type operating on a maximum 4 megawatts rectified dc power with high pressure air as the test gas. The conical nozzles used have 7.19 or 19.36 inch exit diameter, and a 9.5 inch exit diameter Mach 10 contoured nozzle is available. An open jet test section provides a 10 inch test core. Replaceable diffusers are sized to match the available nozzles. The test gas volume is 5000 cu ft at 2800 psia.

TESTING CAPABILITIES: This facility is capable of aerodynamic force, pressure, and heat transfer testing with conventional still and motion picture photography used for flow visualization studies. The model injection system is capable of 14.5 inches axial traverse or pitch angles from -5 to +45 degrees and 360 degrees of roll. In addition, two struts mounted on the sides of the test cabin are used for diagnostic measurements of the test core. All struts are capable of being injected manually, swept to centerline or stepped to centerline. Test data is recorded through a 160 channel analog-to-digital converter on magnetic tape. Final data reduction is accomplished on an on site CDC 160-A Computer. This facility is capable of three runs per day.

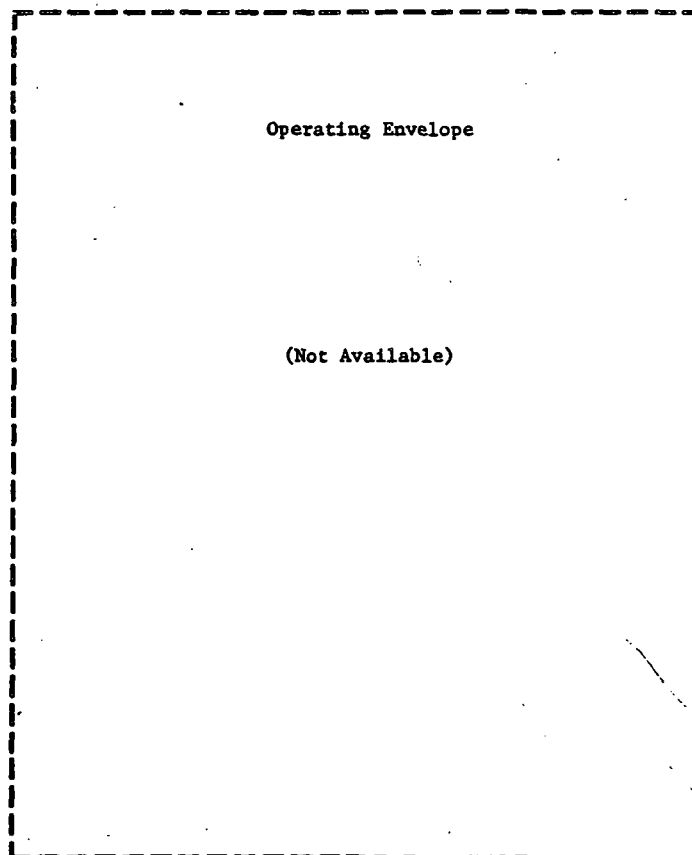
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1963 COST \$4,510,000 ESTIMATED REPLACEMENT VALUE \$9,000,000
CONTRACTOR: In-house effort	LOCATION: Wright-Patterson AFB, Ohio
IMPROVEMENTS AND COSTS: (1965) Data acquisition system, Cost \$48,000; (1964) Model support system, Cost \$92,000; (1966) Vacuum pumping system modification, Cost \$100,000; (1967-69) Air supply system improvements, Cost \$60,000; (1968-69) Arc heater power supply tie in (8 Mw operation), Cost \$285,000; (1969) High pressure water system upgrading, Cost \$60,000; Others Cost \$945,000.	

PLANS FOR FACILITY IMPROVEMENTS: New water-cooled diffuser to match 19.36 inch diameter nozzle; 200 atmosphere arc heater; Mach 9 contoured nozzle.



FACILITY PERFORMANCE DATA



Mach Range:	6 to 12
Reynolds Number ($\times 10^6/\text{ft}$):	.01 to .2
Total Pressure (psia):	200 to 1500
Dynamic Pressure (psf):	30 to 600
Total Temperature ($^{\circ}\text{R}$):	to 12,000
Run Time (minutes):	3 to continuous (depending on conditions)

AFFDL HIGH TEMPERATURE HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION Air Force Flight Dynamics Laboratory (FDMG) Wright-Patterson AFB, Ohio 45433	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: High Speed Aeroperformance Branch (FDMG)
OTHER SOURCES OF INFORMATION: Technical Documentary Report Numbers: ASD TDR 63-456, 1963; AFFDL TM No. FDM TM 67-3, 1967	LOCAL OFFICE TO CONTACT FOR INFORMATION: High Speed Aeroperformance Branch (FDMG) Phone: (513) 255-3061

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is of the blowdown type using high pressure air to vacuum as the driving force. Heat is supplied (1.5×10^5 to 1.5×10^6 Btu/hr) to the air by a refractory pebble bed storage heater. The heater is regenerated between runs by combustion of propane in air. Parallel flow from Mach 8.5 to 11.5 is developed in 24 inch and 32 inch diameter contoured nozzles. An open jet test section is used with a 20 inch diameter test core.

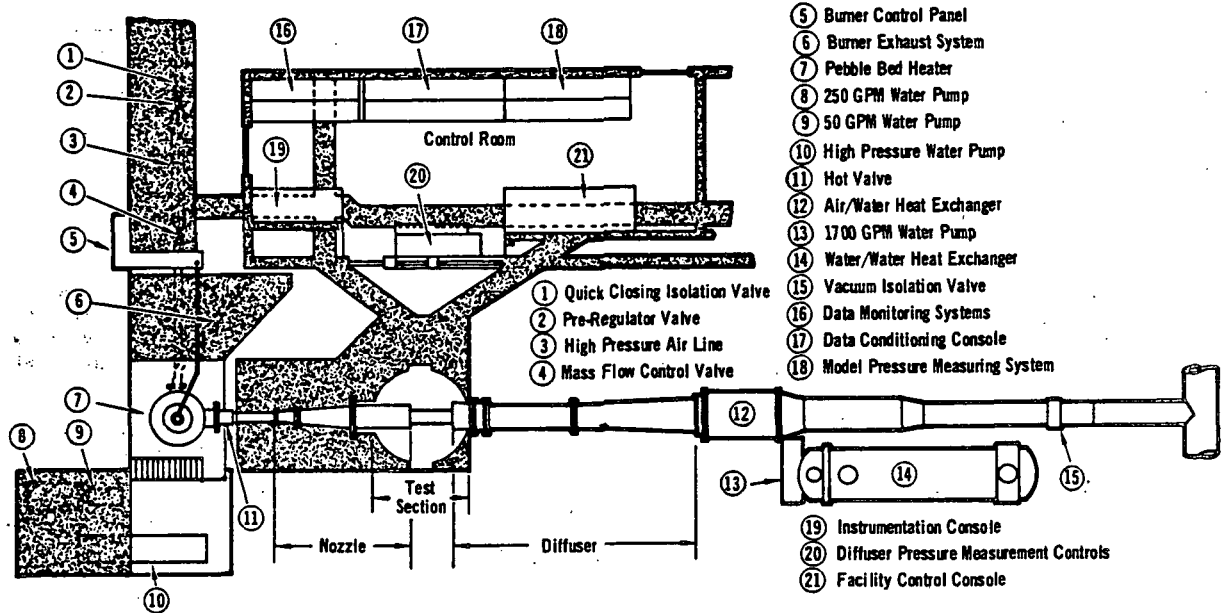
TESTING CAPABILITIES: This tunnel is capable of force and moment, pressure, and heat transfer testing. An infrared sensing system is being installed for thermographic mapping tests. A 20 inch schlieren system is available with both still and motion picture capability. A model support capable of holding two models and pitching to $\pm 30^\circ$ is installed. The support system consists of sting and strut variable angle and injection type supports. Data are recorded using 160 channels and an on site CDC 160A Computer with a CDC 8032 A/D conversion unit. This facility is capable of four runs per day.

FACILITY COST HISTORY

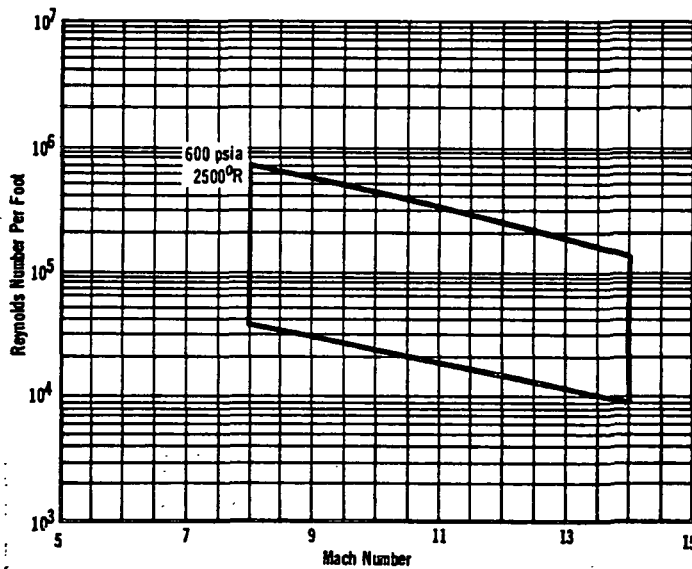
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1958 COST \$ 296,962 ESTIMATED REPLACEMENT VALUE \$1,000,000
CONTRACTOR: Pittsburgh Des Moines Steel Co.	LOCATION: Pittsburgh, Pennsylvania
IMPROVEMENTS AND COSTS: (1961) Mach 8 through 14 test leg, Cost \$342,692; (1962) Side Outlet, Cost \$12,838; (1969-70) Stagnation temperature probe, Cost \$15,999; (1969-70) Infrared thermographic mapper, Cost \$99,500.	

PLANS FOR FACILITY IMPROVEMENTS: Add Mach 5 capability with one foot exit diameter nozzle, increase Reynolds number range by lowering stagnation temperature and/or increase stagnation pressure.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	8.5 to 11.5
Reynolds Number ($\times 10^6/\text{ft}$):	.017 to .7
Total Pressure (psia):	100 to 600
Dynamic Pressure (psf):	.061 to 1.571
Total Temperature ($^{\circ}\text{R}$):	2500 to 4200
Run Time (seconds):	180 to 240

ARL 30-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Aerospace Research Laboratories Wright-Patterson AFB, Ohio 45433	STATUS OF FACILITY: Active (see plans) COGNIZANT ORGANIZATIONAL COMPONENT: Fluid Dynamics Facilities Research Laboratory
OTHER SOURCES OF INFORMATION: Report No. ARL 63-223	LOCAL OFFICE TO CONTACT FOR INFORMATION: ARL (ARF), Wright-Patterson AFB, Phone: (513) 255-2602

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This wind tunnel is an intermittent blowdown to vacuum-type tunnel. A cored brick storage heater provides stagnation temperatures up to 4400°R. The test section is a free jet, 30 inches in diameter with a 20-inch test core. Delivered Mach numbers of 16 to 22 are provided by a conical nozzle with interchangeable throats. The diffuser has a fixed geometry.

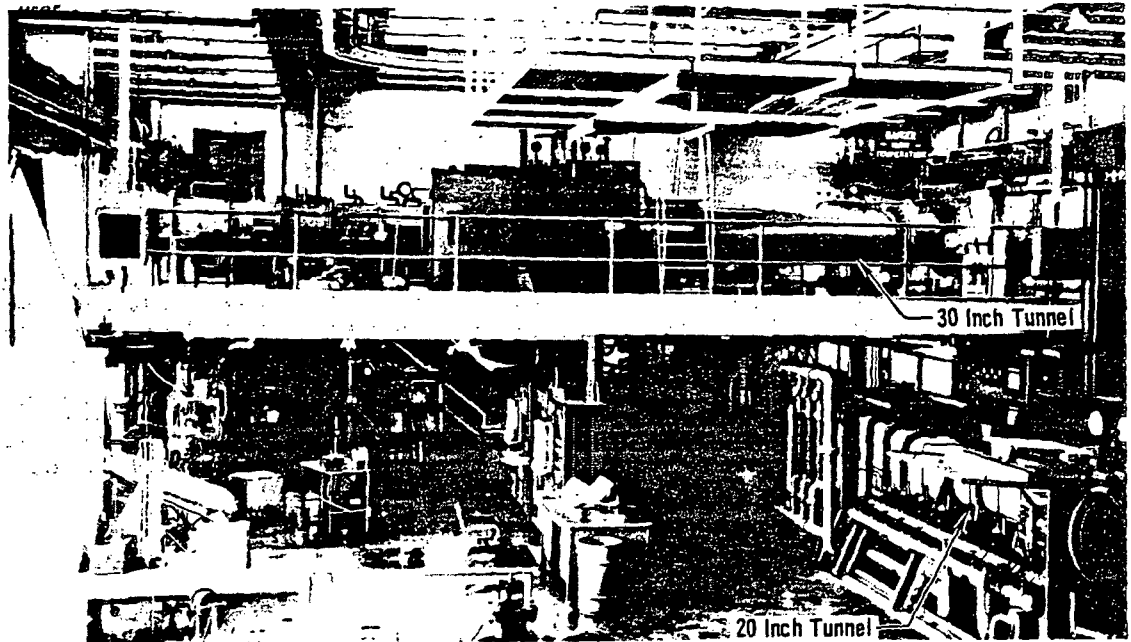
TESTING CAPABILITIES: The free jet length of this tunnel is 30 inches. The test cabin is a 5-foot cube with hinged side walls for accessibility. These side walls contain 14-inch diameter windows for flow visualization apparatus. The pitch range of the model support strut varies from -60° to +20°. Instrumentation is available to make pressure and temperature measurements. Data are recorded with 128 channels on an Adage Ambilog 200 analog-digital system and reduced on site.

FACILITY COST HISTORY

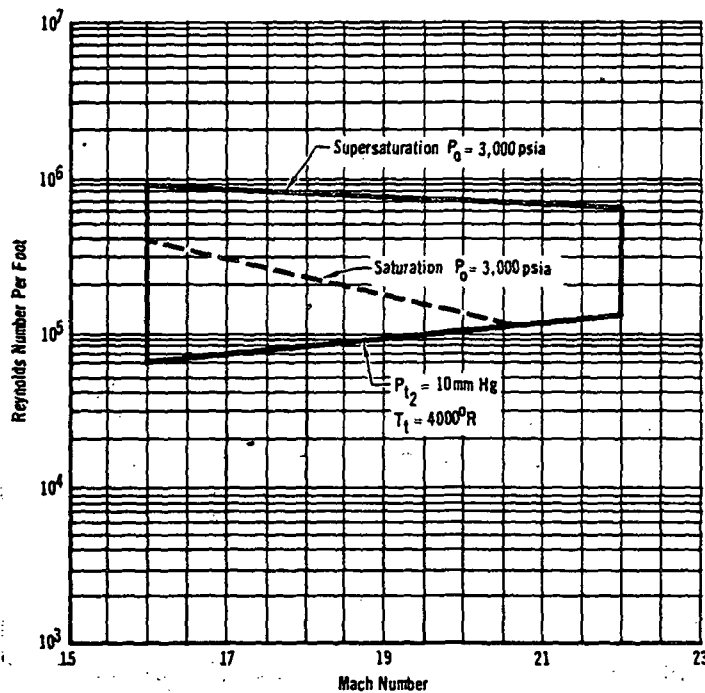
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): (See Note)	CONSTRUCTION YEAR: 1962 COST \$642,000 ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: Fluidyne	LOCATION: Minneapolis, Minnesota
IMPROVEMENTS AND COSTS: (See Note)	
NOTE: It is impractical to break out costs.	

PLANS FOR FACILITY IMPROVEMENTS: This wind tunnel was converted to a facility to study supersonic combustion in 1966. Reconversion to the original facility (described herein) is expected sometime in the future.

SCHEMATIC



FACILITY PERFORMANCE DATA



PERFORMANCE PARAMETERS

Mach Range:	16 to 22
Reynolds Number ($\times 10^6/\text{ft}$):	.1 to 1
Total Pressure (psia):	600 to 2500
Dynamic Pressure (psf):	15 to 25
Total Temperature ($^\circ R$):	3000 to 4400
Run Time (seconds):	30 to 120

ARL 20-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Aerospace Research Laboratories (OAR) Wright-Patterson AFB, Ohio 45433	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Fluid Dynamics Facilities Research Laboratory
OTHER SOURCES OF INFORMATION: Reports: ARL 62-392; ARL 62-393; ARL 63-109; ARL 65-226	LOCAL OFFICE TO CONTACT FOR INFORMATION: ARL (ARF), Wright-Patterson AFB Phone: (513) 255-2602

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is an intermittent blowdown to vacuum type wind tunnel. A 1.6 megawatt, electrical resistance heater provides stagnation temperatures up to 2500°R. The test core is 11 inches in diameter and the test section is a free jet, 20 inches in diameter. Delivered Mach numbers of 12 and 14 are provided by a contoured nozzle with interchangeable throats. The diffuser has a fixed geometry.

TESTING CAPABILITIES: The contoured nozzle of this tunnel may be moved forward or backward in the test cabin to allow free jet lengths of 24 to 48 inches. A diffuser extension is available for use when the free jet length is too great for the tunnel to start. The test cabin is a 4-foot cube with hinged side walls for accessibility. The side walls also contain 14 inch diameter windows for flow visualization apparatus. The pitch range of the model support strut varies from +60° to -60°, depending upon the model blockage of the nozzle. Both a single pass and double pass laser schlieren system are available for flow visualization. Instrumentation is available to make pressure, force, and temperature measurements on test models. Data are recorded with 128 channels on an Adage Ambilog 200 analog-digital system and reduced on site. This facility is capable of 10 to 30 shots per day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): (See Note)	CONSTRUCTION YEAR: 1961 COST \$413,000 ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: (See Note)	LOCATION:
NOTE: These costs are impractical to itemize.	

PLANS FOR FACILITY IMPROVEMENTS:

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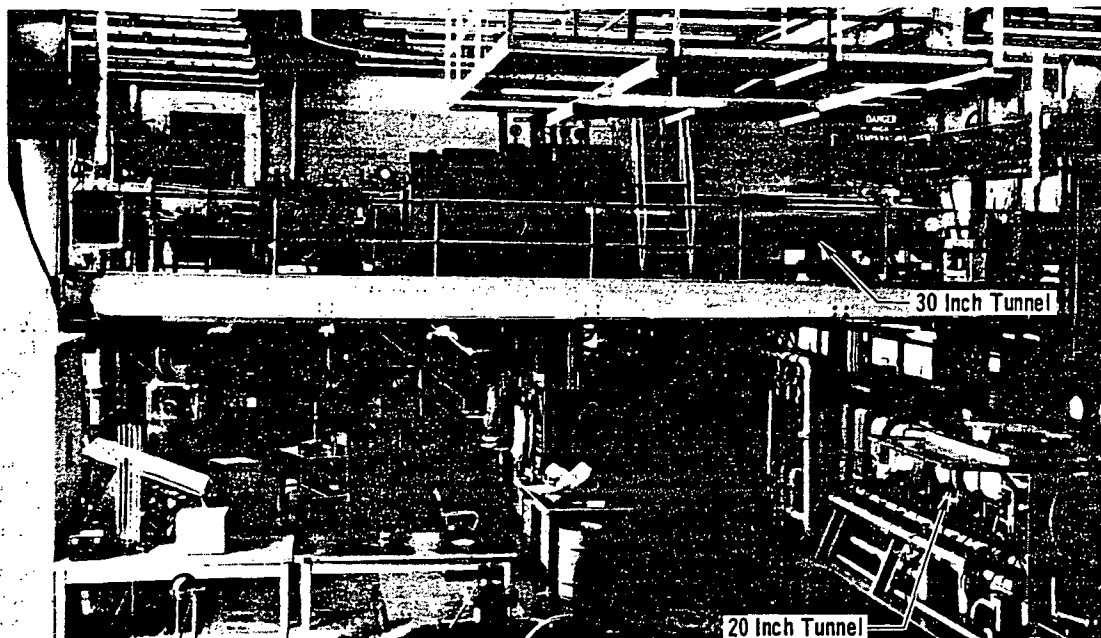
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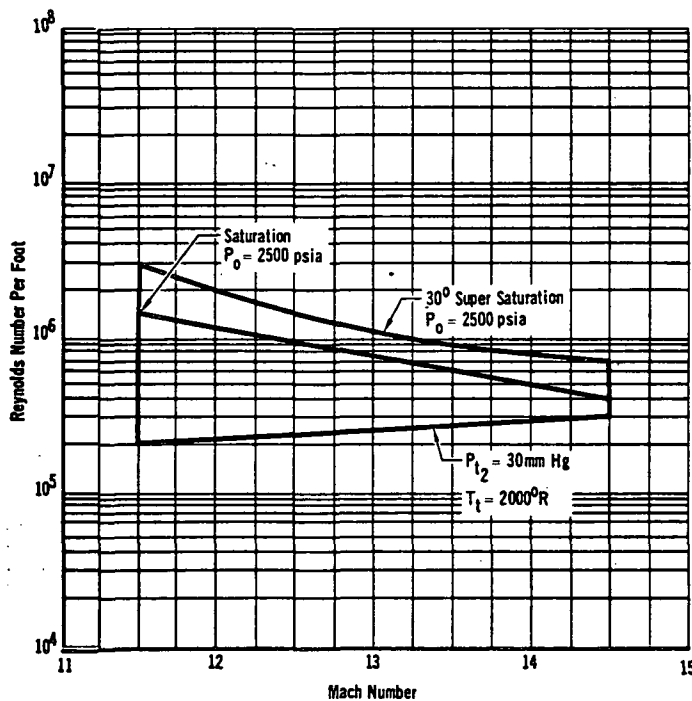
gives access to the

user.

SCHEMATIC



FACILITY PERFORMANCE DATA



PERFORMANCE PARAMETERS

Mach Range:	12 and 14
Reynolds Number ($\times 10^6/\text{ft}$):	.25 to .8
Total Pressure (psia):	400 to 2500
Dynamic Pressure (psf):	20 to 140
Total Temperature ($^{\circ}\text{R}$):	500 to 2500
Run Time (seconds):	20 to 300

AVCO 20-INCH SHOCK TUNNEL

REPORTING INSTALLATION AVCO Systems Division 201 Lowell Street Wilmington, Massachusetts 01887	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Fluid Dynamics Group
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. W. Reinecke Phone: (617) 657-2391

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a combustion or cold gas driven type shock tunnel. The test section is 20 inches in diameter with a test core of 12.5 inches in diameter at $M = 14$. A 7 degree conical nozzle is used. The tunnel has been calibrated at many operational points with each driver. The tunnel test medium can be air, carbon dioxide, nitrogen and argon; the driver medium can be helium, hydrogen or combustion products.

TESTING CAPABILITIES: This facility is capable of pressure and heat transfer type tests. Model mounting consists of variable angle sting or strut type supports. Schlieren and shadowgraph systems are available for flow visualization. Data are recorded on a 40 channel CRO recording system and with an on-site off-line digital computer. This facility is capable of six shots per day.

FACILITY COST HISTORY

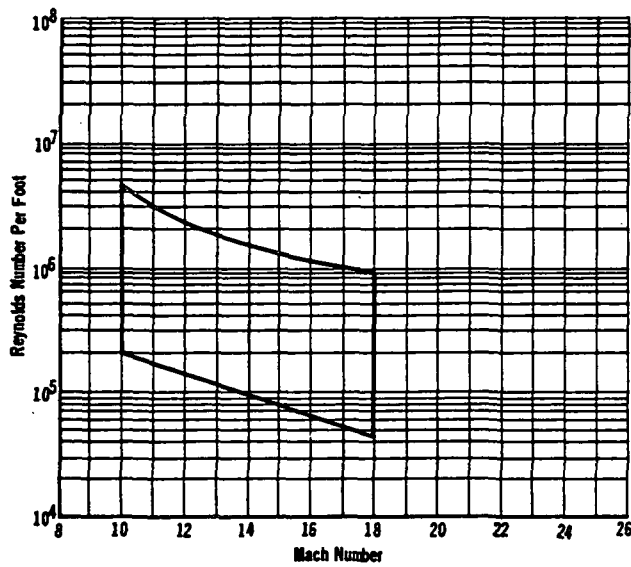
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1957-58 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: (Not available)	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC

(Not Available)

FACILITY PERFORMANCE DATA



Mach Range:	10 to 18
Reynolds Number (x 10 ⁶ /ft):	.04 to 4
Total Pressure (psia):	960 to 18,000
Dynamic Pressure (psf):	Not Available
Total Temperature (°R):	to 5000
Run Time (milliseconds):	to 6

AVCO 10-MEGAWATT MULTI-ARC WIND TUNNEL

REPORTING INSTALLATION: AVCO Systems Division 201 Lowell Street Wilmington, Massachusetts 01887	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Hyperthermal Simulation and Instrumentation Section
OTHER SOURCES OF INFORMATION: AVCO Hyperthermal Simulation Capabilities Report No. AVSD-0006-70-CA	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. Henry E. Hoercher, Section Chief Phone: (617) 657-4406

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This hyperthermal wind tunnel has been in operation at AVCO for several years. The arc-heated gas (air) is obtained from the 10-megawatt-arc plenum chamber. The heated air passes from the plenum chamber through a 7-degree, 29-minute, half-angle conical nozzle to a nominal 12-inch-diameter test section through a diffuser section, and then to a central vacuum system. This test apparatus has been calibrated and is available for major test programs. Run time in the tunnel is presently limited to 60 seconds by the cooling water supply and electrode erosion. Maximum sample size (diameter) is 3 inches based on blocking area. Maximum sample length is 15 inches if the sample is to be wholly within the view port.

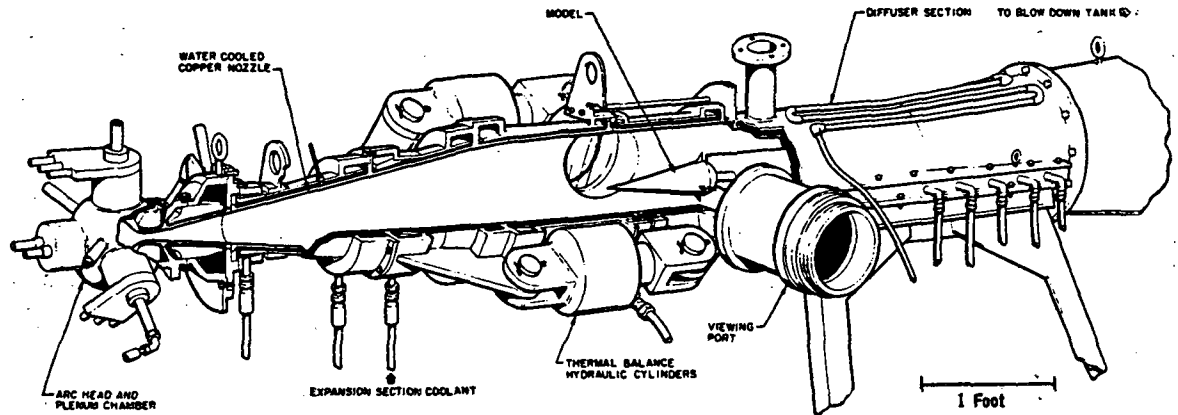
TESTING CAPABILITIES: The high temperature supersonic flow field enables aerodynamic as well as material performance tests to be performed. Pressure and heat transfer effects can be studied in either a steady or trajectory simulation environment. The facility has available a maximum of 30 data acquisition channels. Two ports are available to study tunnel phenomena such as sample geometry changes or general pictorial coverage. Schlieren and shadowgraph systems are available for flow visualization. This facility is capable of four shots per day.

FACILITY COST HISTORY

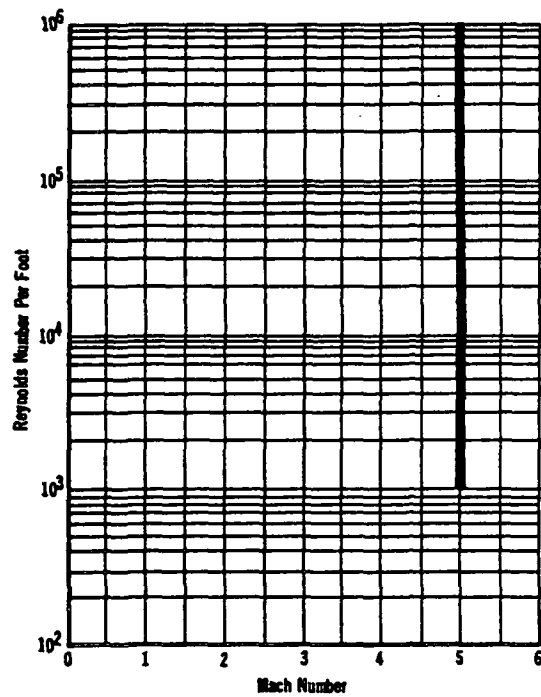
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: (Not Available)	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	5
Reynolds Number ($\times 10^6/\text{ft}$):	.001 to 1
Total Pressure (psia):	7 to 400
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	14,000
Run Time (seconds):	30

BOEING 30-INCH SHOCK TUNNEL

REPORTING INSTALLATION: The Boeing Company Aerospace Systems Division P. O. Box 3999 Seattle, Washington 98124	STATUS OF FACILITY: Active
	COGNIZANT ORGANIZATIONAL COMPONENT: Aerospace Group
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. W. G. Harris Org 2-5740, M.S. 88-47 Phone: (206) 773-1055

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a shock tube driven to vacuum type tunnel. The test section is an open jet with a 30-inch diameter nozzle for Mach numbers of 12 to 16 and a 12-inch exit diameter nozzle for Mach numbers of 5.2 to 8. Both nozzles are contoured and have replacable throats for varying the Mach numbers. The test cores are 8-inches in diameter for Mach 5.2 to 7, and 18 inches in diameter for Mach 12 to 16.

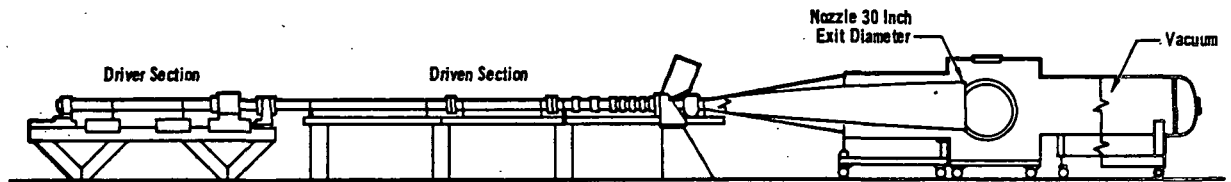
TESTING CAPABILITIES: Pressure, heat transfer, combustion and optical tests are performed at this facility. Models are generally strut mounted in the test sections. No pitch mechanism is available. Pressures are measured using piezoelectric and strain gage pressure transducers. Heat transfer is measured with thin film resistance thermometers and thin skin calorimeter gages. All data are recorded on oscilloscopes or magnetic tape recorders (24 channels). A small schlieren and a spectrograph are available. Data reduction is manual. This facility is capable of four shots per day.

FACILITY COST HISTORY

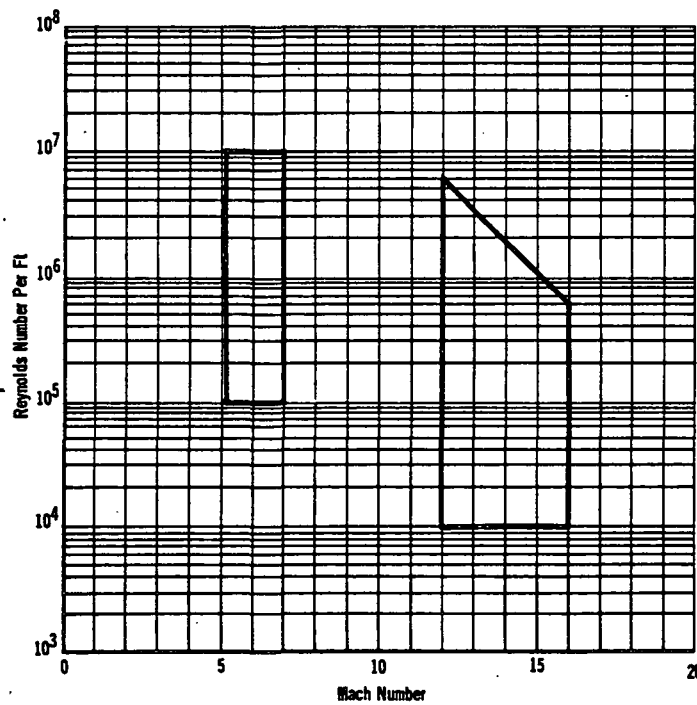
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$280	CONSTRUCTION YEAR: 1962 COST \$ 70,000 ESTIMATED REPLACEMENT VALUE \$180,000
CONTRACTOR: The Boeing Company LOCATION: Seattle, Washington	
IMPROVEMENTS AND COSTS: (1967) Additional driver length, Cost \$3000; (1970) Additional driver and driver tube length, Cost \$30,000; Others plus total through 1969, Cost \$103,000.	

PLANS FOR FACILITY IMPROVEMENTS: Increase driver pressure to 16,000 psi in 1970-1971.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	5.2 to 7; 12 to 16
Reynolds Number ($\times 10^6/\text{ft}$):	.01 to 10
Total Pressure (psia):	1000 to 6700
Dynamic Pressure (psf):	7 to 180,000
Total Temperature ($^{\circ}\text{R}$):	1000 to 14,400
Run Time (milliseconds):	2 to 10

BOEING 12-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: The Boeing Company Aerospace Systems Division P. O. Box 3707 Seattle, Washington 98124	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aerospace Group
OTHER SOURCES OF INFORMATION: None	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. W. G. Harris Org 2-5740, M.S. 9848 Phone: (206) 773-1055

DESCRIPTION AND TESTING CAPABILITIES

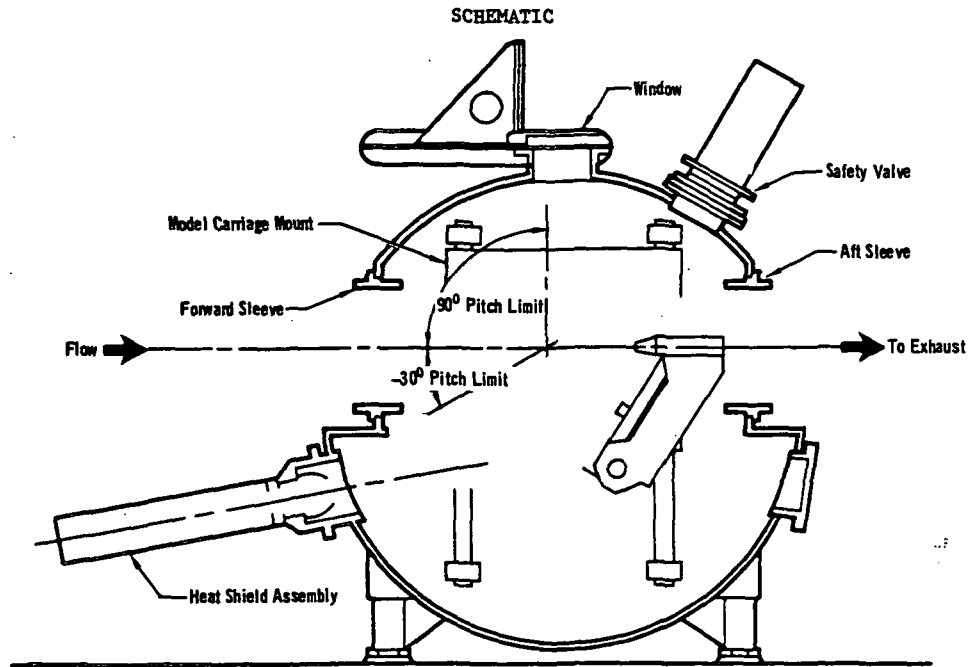
FACILITY DESCRIPTION: The tunnel is an intermittent blowdown type tunnel. The test section is an open jet type with a diameter of 12 inches and a test core of 8 inches. An oil fired heat exchanger is used to raise the temperature of the air to between 1110° and 1460°R, depending on test conditions. An air drying system reduces the dew point of the air supply to -60°F. A separate axisymmetric nozzle is available for each of the three operating Mach numbers. A variety of easily interchanged diffusers is available.

TESTING CAPABILITIES: The tunnel is used for applied research in aerodynamics, aerothermodynamics, and development of testing techniques. A hydraulically operated mount on which a model may be injected into the already flowing and stabilized airstream is enclosed in the test section chamber. Programming of model attitude and data recording is automatic during a run. Schlieren, shadowgraph and photography are used for flow visualization. Data are recorded on 13 channel strip chart recorders and card-punch and reduced off site manually and by computer.

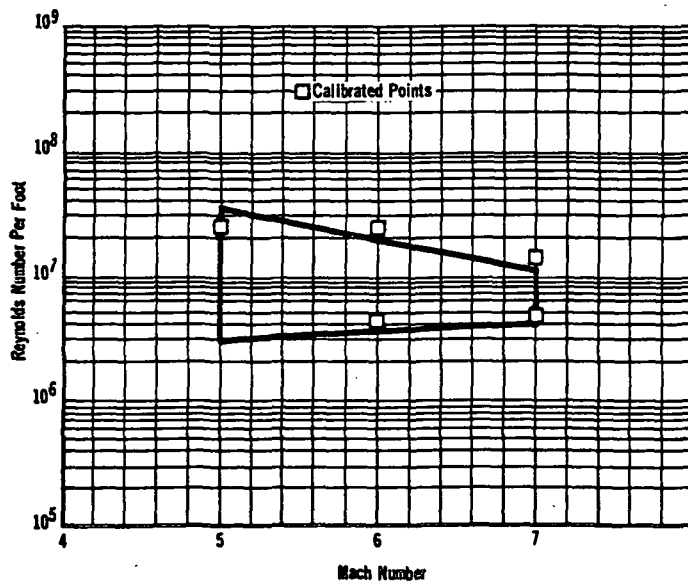
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$350	CONSTRUCTION YEAR: 1962 COST \$250,000 ESTIMATED REPLACEMENT VALUE \$375,000
CONTRACTOR: The Boeing Company IMPROVEMENTS AND COSTS: (1963) Additional instrumentation, Cost \$2000; (1965) Upgrade schlieren system, Cost \$2070; Others plus total through 1969, Costs \$254,070.	

PLANS FOR FACILITY IMPROVEMENTS: None



FACILITY PERFORMANCE DATA



Mach Range: 5, 6, 7
 Reynolds Number ($\times 10^6/\text{ft}$): 3.4 to 35
 Total Pressure (psia): 260 to 1600
 Dynamic Pressure (psf): 1140 to 2380
 Total Temperature ($^{\circ}\text{R}$): 1170 to 1460
 Run Time (seconds): 60 to 120

BRL HYPERSONIC WIND TUNNEL NO. 4

REPORTING INSTALLATION: Ballistics Research Laboratories Exterior Ballistics Laboratory Aberdeen Proving Grounds, Maryland 21005	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Wind Tunnels Branch, Exterior Ballistics Laboratory
OTHER SOURCES OF INFORMATION: Reports No. BRL-MR1292 July 1960	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. Robert H. Krieger, Chief, Wind Tunnels Branch Mr. M. A. Sylvester, Chief, Program Engr Section, Wind Tunnel Branch; Phone: (301) 278-4773

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a closed circuit, single return, continuous flow, variable density hypersonic wind tunnel. Three replaceable axisymmetric nozzles are utilized to provide a variation of flow Mach number of $M = 6.0, 7.5$, and 9.2 . The nozzle exits vary in size from 14-1/2 inch diameter at $M = 6$ to 18-3/4 inch diameter at $M = 9.2$ to provide a constant core flow diameter of approximately 12 inches. The test region flow is a 27 inch long free jet confined within a water cooled plenum chamber. Flow direction is considered to be essentially axial. A thermal equalizer (flow mixer) is used in the supply section to reduce the gravity generated stratification of temperature. Air-humidity is controlled to approximately specific humidity $< .0003$ and sufficient heat is put into the process air by two heaters (combustion first stage and electric final stage) to avoid liquefaction of air constituents. The widely ranging supply temperature capability in conjunction with a 100 psia to 2200 psia range of supply pressure permits a larger than normal excursion of test Reynolds number. A variable supersonic diffuser permits adjustment of the plenum chamber pressure and assists starting of flow. All structure from the supply heater to the tunnel aftercooler is continuously cooled by circulating water systems. The 30 inch diameter optical quality test section windows are protected by thermal barriers. Large doors provide access to the plenum chamber. A 20 inch diameter window in the blow off over-pressure protector permits orthogonal viewing of the free-flying models and a model catching grid just ahead of the tunnel aftercooler protects the heat exchanger from being damaged. The tunnel is powered by two compressor systems. Plant No. 1 (the supersonic tunnel power supply) is used as the first stage. It is followed by as many as necessary of the three compressors of Plant No. 2. These again are centrifugal flow machines and have a total maximum continuous power rating of 15,500 hp. The air supply heaters have ratings of 29,300,000 Btu/hr maximum continuous for the first stage and 1000 kW maximum continuous for the final (fine control) stage. Dry make-up air and high pressure auxiliary air systems are the same source as for the BRL Supersonic Wind Tunnels. An oil remover precipitron is placed in line in the process air circuit between the compressor plants to inhibit the passage of oil vapors. Also, oil detection devices are employed to monitor oil vapor condition at the various compressors.

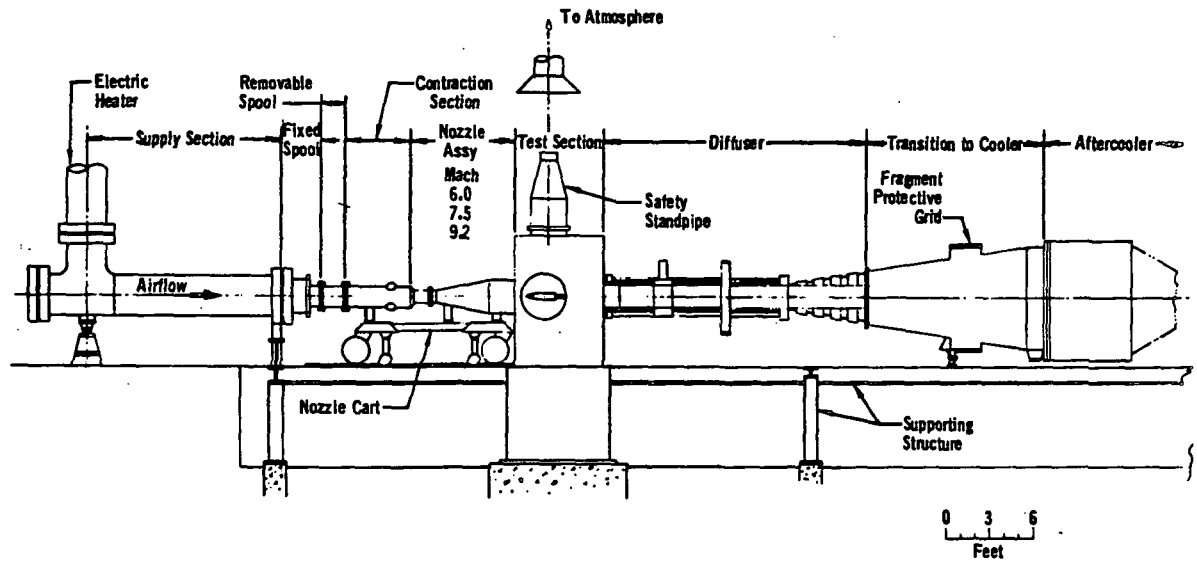
TESTING CAPABILITIES: This facility is capable of: static force and moment, pressure, temperatures and heat transfer, jet interaction and rocket exhaust, shock wave interaction, air liquefaction, damping-in-pitch, free flight for sting-free measurements (nonspinning configurations or Magnus), flow and boundary layer surveys, high-speed injection models, and high temperature materials testing. Models are supported from a double parallelogram slide arrangement which permits model excursions in both angular and linear traverse. Pitch range is ± 15 degrees. Heat transfer models can rapidly be removed from or injected into the airstream. The slide for holding sting supported models can be replaced by a launcher for free flight models or by other kinds of special devices. A model cart is available to allow model configurations to be set up and calibrated in advance and water-cooled 6-component TASK balances are specially compatible with the higher temperature hypersonic environments encountered in the facility. A Schlieren system is available. Data are recorded on a 10-channel Dynometrics system or a 50-channel Astrodata high speed system and reduced off site on the BRLESC I and BRLESC II systems.

FACILITY COST HISTORY

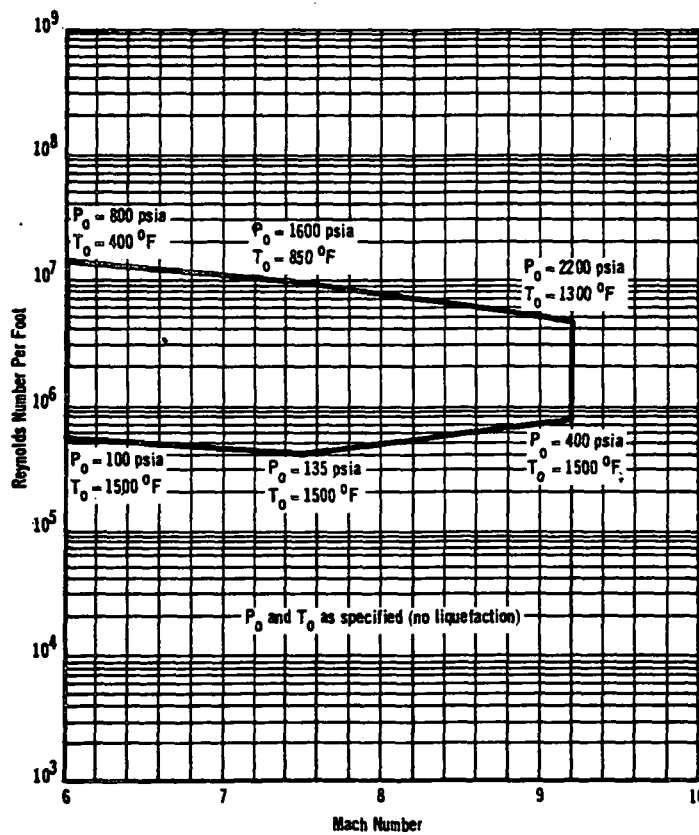
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$8000	CONSTRUCTION YEAR: 1961 COST \$3,130,000 ESTIMATED REPLACEMENT VALUE \$6,500,000
CONTRACTOR: Consolidated-Western Div., U.S. Steel Corp. LOCATION: Los Angeles, California IMPROVEMENTS AND COSTS: (1944) Air handling equipment, shared with tunnels Number 1, 2 and 3, Cost \$750,000 tunnel Number 4 only; (1948-60) Air system improvements, Cost \$250,000 tunnel Number 4 only; (1959) Building Number 120 annex, Cost \$900,000; (1960) Dynometrics 10-channel readout system, Cost \$200,000; (1969) Data acquisition system, shared with tunnels 1 and 3, Cost \$75,000 per tunnel; Others Cost \$125,000.	

PLANS FOR FACILITY IMPROVEMENTS: 1) New supersonic diffuser; 2) Supply header turning vanes and turbulence damper for free-flight model testing; 3) Smoke removal (antipollution) for combustion heater warm-up cycle.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	6; 7.5; 9.2
Reynolds Number ($\times 10^6/\text{ft}$):	.4 to 15
Total Pressure (psia):	100 to 2200
Dynamic Pressure (psf):	115 to 1700
Total Temperature (°R):	860 to 1960
Run Time:	Continuous

CORNELL 96-INCH HYPERSONIC SHOCK TUNNEL

REPORTING INSTALLATION: Cornell Aeronautical Laboratory, Inc. P.O. Box 235 Buffalo, New York 14221	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Hypersonic Facilities Department
OTHER SOURCES OF INFORMATION: Description and Capabilities, Cornell Aeronautical Laboratory Hypersonic Shock Tunnel May 1969.	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. James F. Martin, Head Hypersonic Facilities Department Phone: (716) 632-7500, ext 235

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a shock tube driven wind tunnel with a 96-inch diameter test section and an 18 to 36 inch diameter core. The shock tube is chambered having an area ratio of 1.56. A 5-inch i.d. driver is 16 feet long and is externally heated by a resistance heater to 1260°R. A 4-inch i.d. driven tube is 48.5 feet long. A hydrogen-nitrogen or helium-air mixture is used as the driver gas. Air is generally the driven gas, although other gases may be used. Four axisymmetric nozzles are available: a 24-inch exit diameter nozzle contoured for Mach No. 8; a 48-inch exit diameter nozzle contoured for Mach No. 16; 48-inch and 72-inch exit diameter conical nozzles (10-1/2° half angle). The test gas volume before the run is 4.24 cu ft with 20,000 psia behind the reflected shock; the driver gas volume is 2.2 cu ft with a maximum pressure of 30,000 psia.

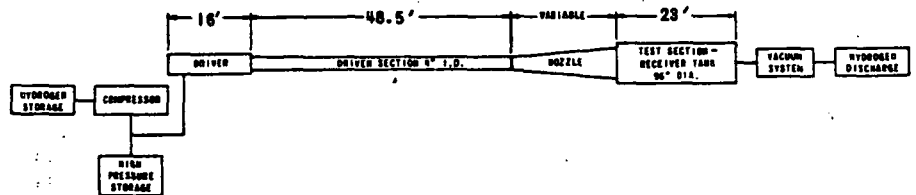
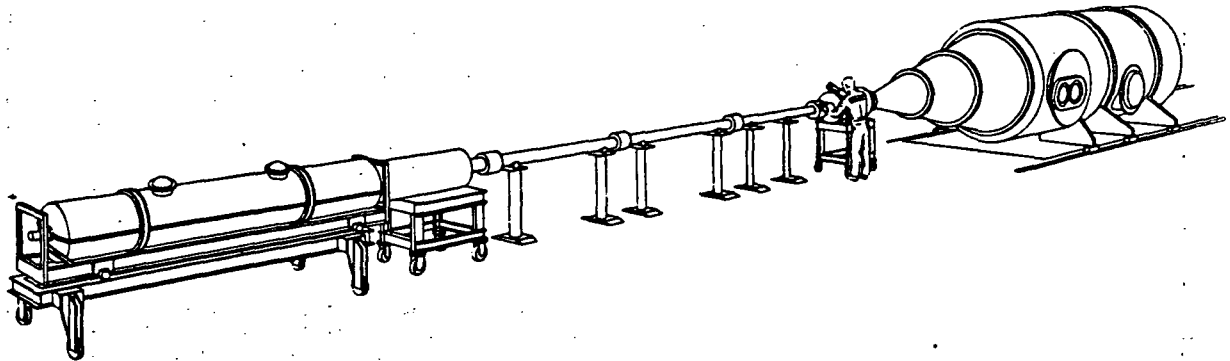
TESTING CAPABILITIES: Force and moment, pressure, heat transfer and skin friction measurements are routinely made on hypersonic configurations. Tests have also been conducted in the field of blast-wave effects, microwave-plasma interaction, and wake phenomena including the scattering of microwaves from the wake. Models are sting mounted and attached to a vibration-isolated sector that provide for variation of the angle of attack. Auxiliary test equipment consists of: Schlieren and shadowgraph systems, high speed movie system, dielectric test section, electron beam, microwave interferometer and pulse doppler radar (X-band). Data are recorded with a 48 channel NAVCOR digital data acquisition system (48 additional channels can be recorded on oscilloscopes) and reduced on an IBM S/360-65 on site computer system. This facility is capable of four to five runs per shift.

FACILITY COST HISTORY

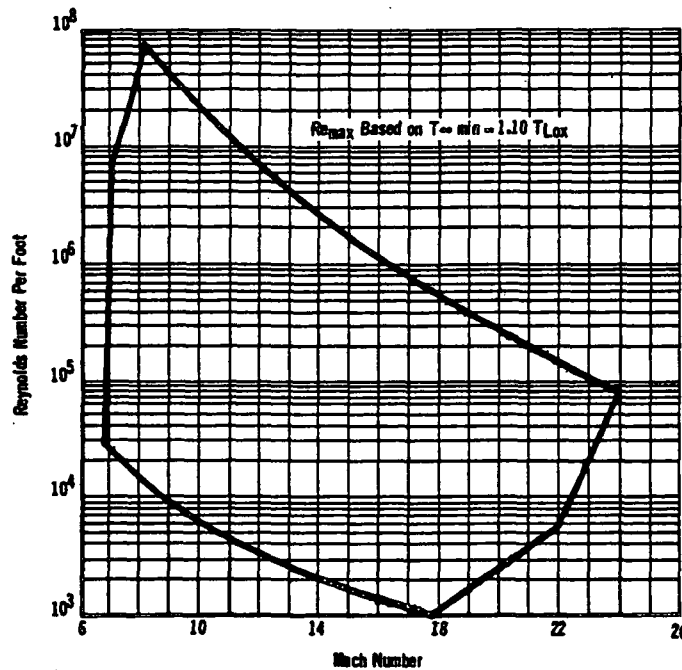
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2600 (See Note)	CONSTRUCTION YEAR: 1963 COST \$ 750,000* ESTIMATED REPLACEMENT VALUE \$1,000,000*
CONTRACTOR: Cornell Aeronautical Laboratory IMPROVEMENTS AND COSTS:	LOCATION: Buffalo, New York
NOTE: Typical pre and post test cost; 6 component force test, Cost \$21,000; Heat transfer or pressure test with 42 model instruments, Cost \$17,000. *Cost includes land and building.	

PLANS FOR FACILITY IMPROVEMENTS: (1) Provide a 48-inch exit diameter nozzle contoured for Mach 10,
(2) Provide longer run time by doubling driver tube size and driven tube diameter.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	6.5 to 24
Reynolds Number ($\times 10^6/\text{ft}$):	.001 to 75
Total Pressure (psia):	1000 to 20,000
Dynamic Pressure (psf):	To 20,000
Total Temperature ($^{\circ}\text{R}$):	1300 to 11,500
Rm Time (milliseconds):	2 to 6

CORNELL 48-INCH HYPERSONIC SHOCK TUNNEL

REPORTING INSTALLATION: Cornell Aeronautical Laboratory, Incorporated P. O. Box 235 Buffalo, New York 14221	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Hypersonic Facilities Department
OTHER SOURCES OF INFORMATION: Description and Capabilities, Cornell Aeronautical Laboratory Hypersonic Shock Tunnel, May 1969	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. James F. Martin, Head Hypersonic Facilities Department Phone: (716) 632-7500, ext 235

DESCRIPTION AND TESTING CAPABILITIES

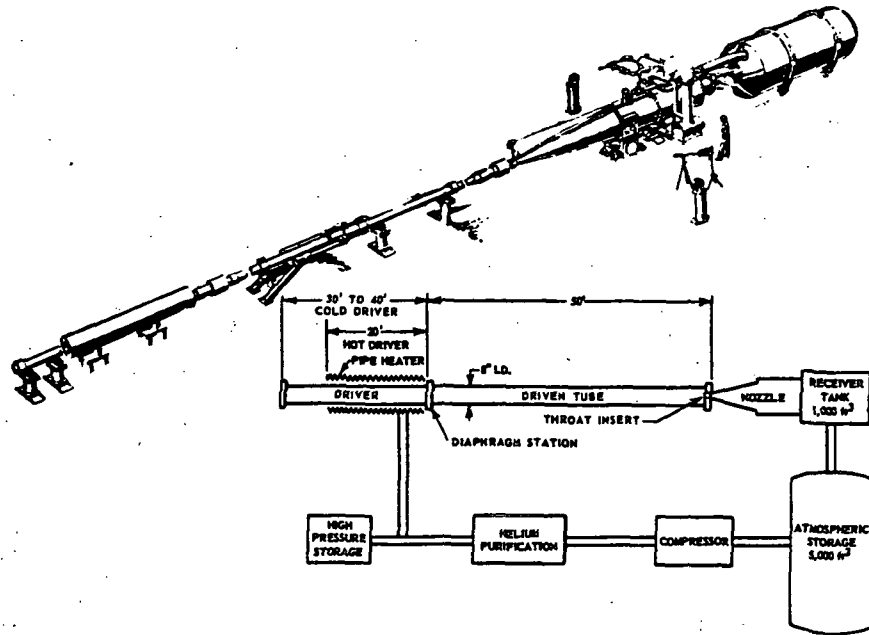
FACILITY DESCRIPTION: This is a shock tube driven wind tunnel with a 48-inch diameter test section. The shock tube has a constant internal diameter of 8-inches with a 20-foot long driver and a 50-foot long driven tube. The driver is externally heated by a resistance heater to 1460°R and can be loaded with mixtures of helium and air to a maximum pressure of 6000 psia. Four nozzles are available: a 24-inch exit diameter nozzle contoured for Mach No. 8; a 24-inch exit diameter conical nozzle (10-1/2° half angle); a 48-inch exit diameter nozzle contoured for Mach 16; a 48-inch exit diameter conical nozzle (10-1/2° half angle). The test gas volume before the run is 17.5 cu ft with a maximum pressure behind reflected shock of 5400 psia. The driver gas volume is 6.98 cu ft at a maximum pressure of 6000 psia.

TESTING CAPABILITIES: Force and moment, pressure, heat transfer and skin friction measurements are routinely made on hypersonic configurations. Tests have also been conducted with an electron beam apparatus to measure the density profile in a laminar boundary layer. Models are sting mounted and attached to a vibration-isolated sector that provide for variation of the angle of attack. Schlieren and shadow-graph systems are available for flow visualization. Data are recorded with a 48 channel NAVCOR digital data acquisition system (48 additional channels can be recorded on oscilloscopes) and reduced on an IBM S/360-65 on-site computer system.

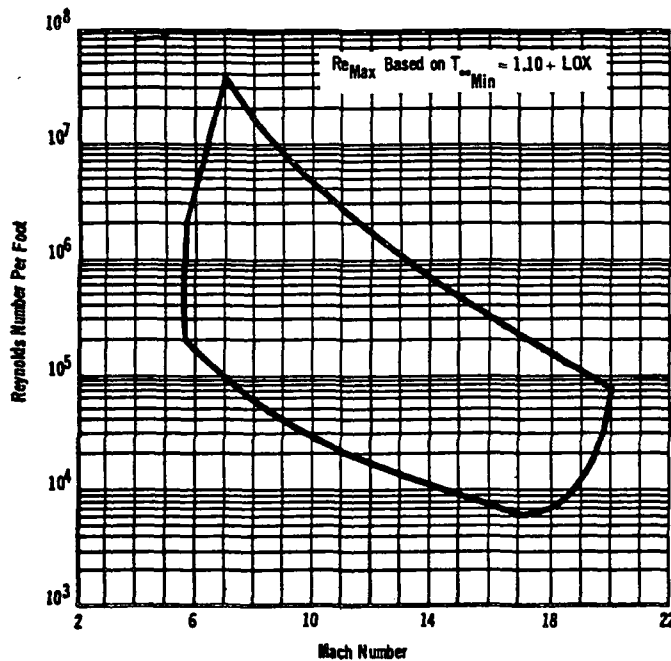
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2600 (See Note)	CONSTRUCTION YEAR: 1959 COST \$600,000*
CONTRACTOR: Cornell Aeronautical Laboratory	ESTIMATED REPLACEMENT VALUE \$800,000*
IMPROVEMENTS AND COSTS:	LOCATION: Buffalo, New York
NOTE: Typical pre and post test cost: 6-component force test, Cost \$21,000; Heat transfer or pressure test with 42 model instruments, Cost \$17,000.	
*Cost includes land and building	
PLANS FOR FACILITY IMPROVEMENTS:	

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	5.5 to 20
Reynolds Number ($\times 10^6/\text{ft}$):	.006 to 40
Total Pressure (psia):	200 to 5400
Dynamic Pressure (psf):	To 5750
Total Temperature ($^{\circ}\text{R}$):	1100 to 5800
Run Time (milliseconds):	4 to 13

CORNELL WAVE SUPERHEATER HYPERSONIC TUNNEL

REPORTING INSTALLATION: Cornell Aeronautical Laboratory, Inc. P.O. Box 235 Buffalo, New York 14221	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Wave Superheater Department (88)
OTHER SOURCES OF INFORMATION: CAL Wave Superheater - Design and Capabilities Improved June 1968 - SAMSO TR-68-364	LOCAL OFFICE TO CONTACT FOR INFORMATION: Head-Wave Superheater Department (88) Phone: (716) 632-7500

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The Wave Superheater facility consists of a common hot gas generator, the Wave Superheater, and a series of collectors, nozzles, and ducts in which the gas may be collected and expanded to the desired supersonic or hypersonic flow conditions. This hot gas generator is a rotating multiple-shock device capable of delivering up to 8 lb/sec flow of uncontaminated test gas for durations up to 15 seconds. This facility generates a flow of high pressure, high enthalpy gas by the use of the shock tube principle. A long duration flow of gas is obtained by mounting a series of shock tubes on the periphery of a rotating drum or rotor and cyclically actuating the tubes once per revolution. Each tube generates a single slug of gas, which has a length of approximately one foot and requires 150 microseconds to flow from the tube; a new shock is generated every 100 microseconds. Consequently, at least one tube is discharging at all times, which results in a continuous flow of gas for testing. With a test medium of air, a gas flow with an effective maximum reservoir enthalpy of 2975 Btu/lb_m at a pressure of 130 atm and a temperature of 8240°R may be generated. A maximum total pressure of 200 atmospheres may be obtained at an enthalpy of 1600 Btu/lb.

TESTING CAPABILITIES: Facility consists of seven (7) complete test systems. Testing in the free jet is generally restricted to either wedge or stagnation point ablation experiments where extremely high heat flux and pressure is required. A flow straightener has been developed which supplies a more symmetrical environment than the free jet and with only a 10-15% reduction in maximum stagnation pressure. Subsonic or sonic turbulent boundary layer ablation tests can be conducted in a collector pipe assembly at sonic static pressures up to 50 atm. A turbulent boundary layer channel operating at Mach numbers over 2 is equipped to obtain information such as chemical composition, microwave transmission characteristics and distribution of electron density, stagnation pressure and enthalpy in the boundary layer of an ablating wall. The three aerodynamic nozzles (M = 3, 6, 12) are used to generate a test environment to evaluate the effects of ablation products on aerodynamics, observables, and plasma attenuation. Static six-component balances, dynamic balances, heat flux gages, pressure transducers, shadowgraph/schlieren, pyrometers, spectrographs, high speed cameras, and microwave generators and receivers are available to provide the required data for each of the test systems. This facility is capable of a maximum of 18 runs per day or any combination of run times up to 40 seconds per day.

(Enthalpy - 2800 Btu/lb)

Test Section	M _∞	q _w (a)	Velocity	P ₀ Atm	D _{Nozzle}	D _{Stream}	Q _{Model}
Rotor Free Jet:							
High Enthalpy Mode	1.8-4	12,000(b)	—	110	—	0.5"	0.5"
High Pressure Mode	1.7-4	8,400(b)	—	160	—	0.5"	0.5"
Flow Straightener:							
High Enthalpy Mode	1.6-4	—	—	100	1.40"	1.25"	1.0"
High Pressure Mode	1.6-4	—	—	125	1.40"	1.25"	1.0"
Sonic Pipe	1.0	4,750	—	90	1.0"	—	—
Mach 2	2.0-2.5	1,000	7,000 ft/sec	25	1.7 x 1.7	—	—
Mach 3	3.0-3.5	2,800	9,300 ft/sec	17	2.5"	2.3"	1.5"
Mach 6	5.2-6.3	900	11,000 ft/sec	1.8	8.0"	7.5"	4.0"
Mach 12	11.0-13.5	150	11,600 ft/sec	0.046	72.0"	40.0"	16.0"

(a) q_w is the cold wall stagnation heat flux, expressed in Btu/ft²-sec, to a 0.25 - inch radius spherical nose. The sonic pipe and Mach 2 tunnel are primarily turbulent boundary layer channels. For these test sections, q_w should be replaced by q_w s where s is the distance from the sample leading edge expressed in feet.

(b) Preliminary calibration - only one data point.

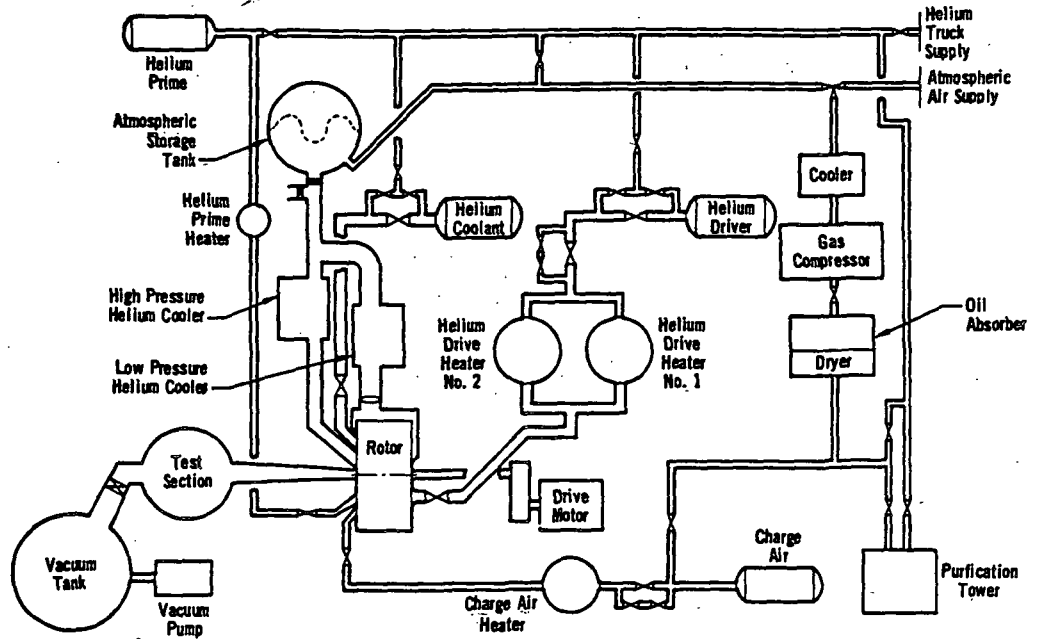
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$14,000* (See Note)	CONSTRUCTION YEAR: 1959-62 COST \$2,682,644 ESTIMATED REPLACEMENT VALUE \$7,500,000
CONTRACTOR: Cornell Aeronautical Laboratory Inc.	LOCATION:
IMPROVEMENTS AND COSTS: (1963-69) Major equipment, Cost \$568,898; (1967-68) Performance upgrading, Cost \$91,287.	

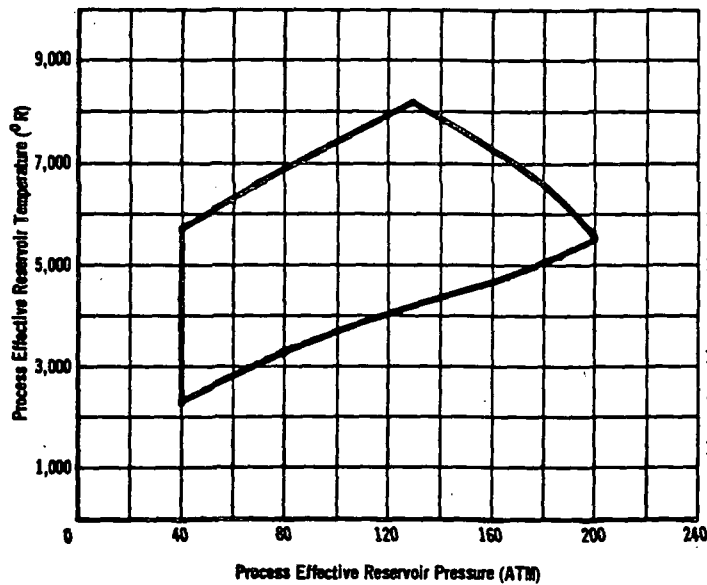
*NOTE: Varies with test complexity; Pre-Test - \$600; Data Report - \$2500.

PLANS FOR FACILITY IMPROVEMENTS: Advanced instrumentation and test technique. Capability for testing exists (negotiations with government in process to determine operational future).

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	1 to 12
Reynolds Number ($\times 10^6/\text{ft}$):	.028 to 4
Total Pressure (psia):	2870
Dynamic Pressure (psf):	Not Available
Total Temperature (°R):	4000 to 8000
Run Time (seconds):	3 to 20

FLUIDYNE 20-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Fluidyne Engineering Corporation 5900 Olson Memorial Highway Minneapolis, Minnesota 55422	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION: Company Booklet	LOCAL OFFICE TO CONTACT FOR INFORMATION: Dr. James S. Holdhusen, Vice President Phone: (612) 544-2721

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is an intermittent blowdown to vacuum facility. The test section is a free jet type with a 12-inch test core at $M = 11$. The tunnel is equipped with fully contoured nozzles for $M = 7, 11$ and 14 . A zirconia heater is used providing 5600 Btu/sec of heat added to a test gas volume of 60 cu ft and a maximum pressure of 5000 psia. A 100 hp compressor with 5 stages of compression initiates the pressurization of the plenum.

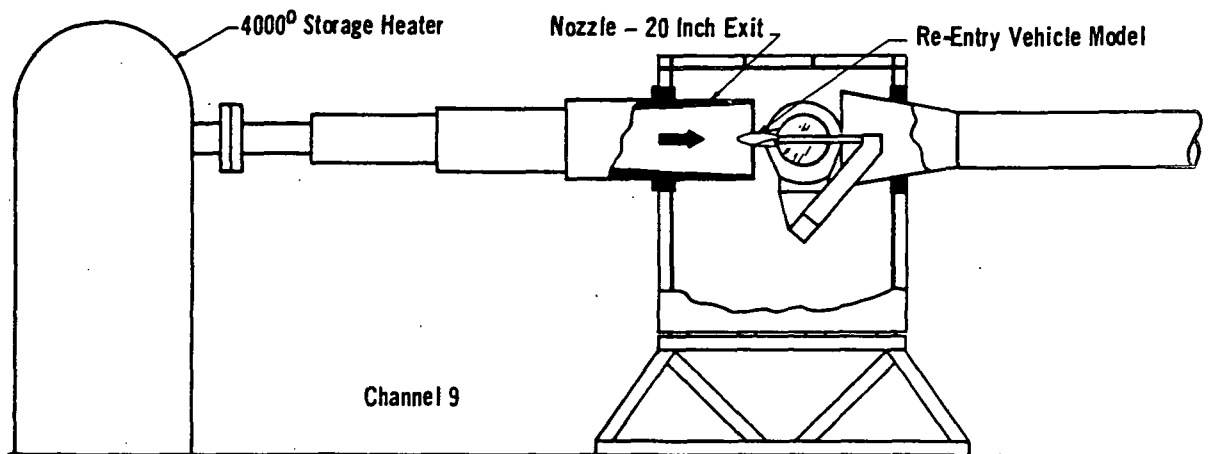
TESTING CAPABILITIES: Force and moment, pressure, heat transfer, dynamic stability, inlet studies, and effluxing gas models are types of testing available at this facility. Model mounting consists of sting or strut mounting. The model support mechanism can cover 90° of pitch range during a run at pitch rates from 1 to 20 degrees per second. A schlieren system and glow probe technique are available for flow visualization. Data recording consists of an analog (54 channels) and a digital (20 channels) recording system. Data reduction system is an on-site time shared computer.

FACILITY COST HISTORY

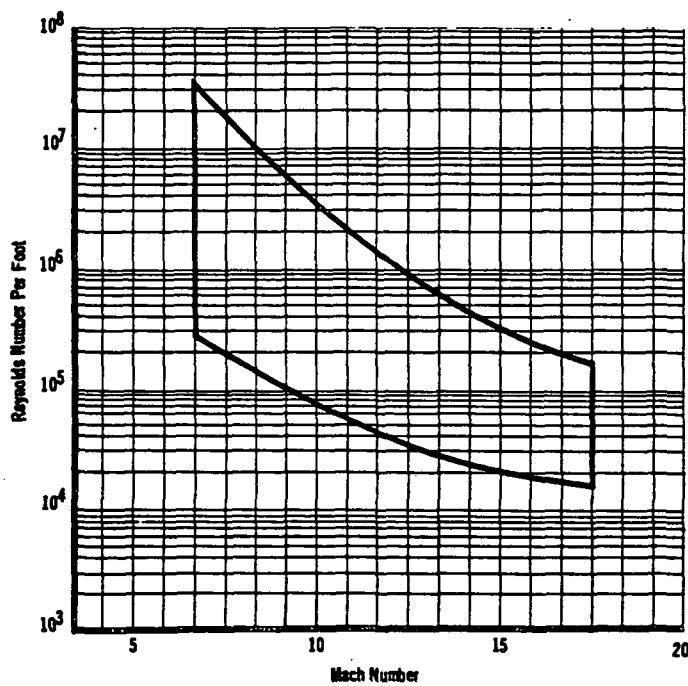
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$8000	CONSTRUCTION YEAR: 1960 COST \$1,000,000 ESTIMATED REPLACEMENT VALUE \$1,500,000
CONTRACTOR: Fluidyne Engineering Corporation IMPROVEMENTS AND COSTS:	LOCATION: Medicine Lake Laboratory

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	7 to 18
Reynolds Number ($\times 10^6/\text{ft}$):	.02 to 20
Total Pressure (psia):	300 to 2000
Dynamic Pressure (psf):	1.44 to 1440
Total Temperature (°R):	1200 to 4000
Run Time (sec):	60

GENERAL DYNAMICS 18-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: General Dynamics Corporation Convair Division P.O. Box 1950 San Diego, California 92112	STATUS OF FACILITY: Active
	COGNIZANT ORGANIZATIONAL COMPONENT: General Dynamics Aeromarine Test Facilities
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Department 507-0, P.O. Box 1950 San Diego, California 92112 Phone: (714) 296-6611, ext 1032

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown type facility. This facility has an 8 x 6 foot long test chamber with an 18-inch test section providing up to a 13.5-inch test core. The tunnel is equipped with a gas fired heater that adds nine million Btu/hr of heat to the system. A contoured axisymmetric contoured nozzle with interchangeable throats provides for nominal Mach numbers of 8, 10 and 12.

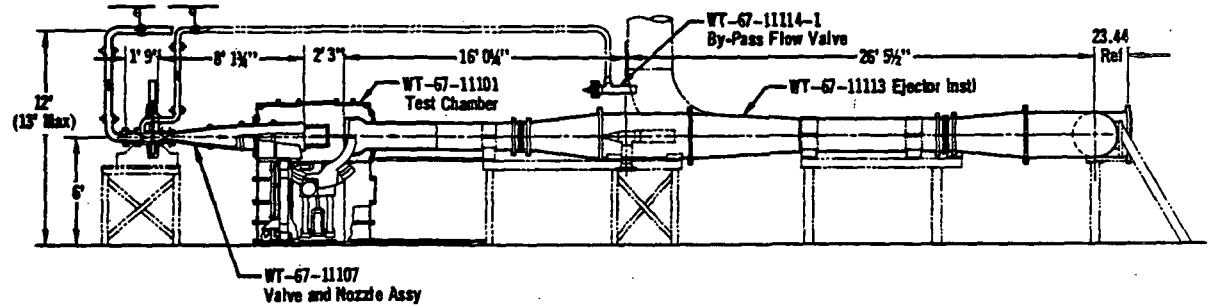
TESTING CAPABILITIES: A model support is provided to both inject the model into the flow after the tunnel starts and to pitch the model during a run. The model injection is hydraulically actuated and positions the model on the tunnel centerline or 25 inches below, in the lower portion of the test chamber. The model support has a pitch range of -15° to +45°. Data are recorded on a 50 channel recording system and reduced on site by an IBM 1800 reduction system. This facility can make an average of six runs per day.

FACILITY COST HISTORY

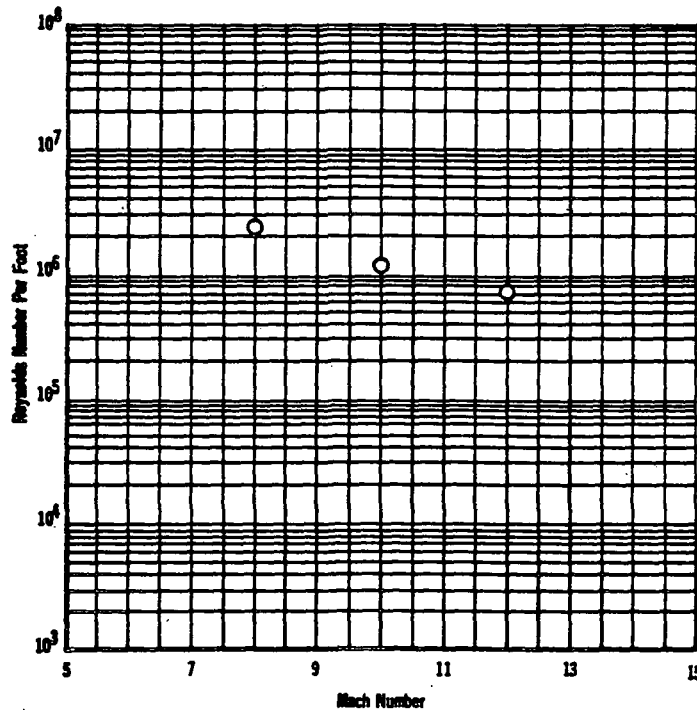
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2800	CONSTRUCTION YEAR: 1968 COST \$160,000 ESTIMATED REPLACEMENT VALUE \$200,000
CONTRACTOR: Convair Division of General Dynamics IMPROVEMENTS AND COSTS: Not available.	LOCATION: San Diego, California

PLANS FOR FACILITY IMPROVEMENTS:

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 8, 10, 12

Reynolds Number ($\times 10^6/\text{ft}$): 2.28, 1.3, .73

Total Pressure (psia): 525

Dynamic Pressure (psf): To 2.5

Total Temperature ($^{\circ}\text{R}$): 1320 to 1460

Run Time (min): 0 to 2

GENERAL ELECTRIC 54-INCH SHOCK TUNNEL

REPORTING INSTALLATION: General Electric Company P.O. Box 8555 Philadelphia, Pennsylvania 19101	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Re-entry and Environmental Systems Division
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (215) 962-3009

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is a combustion driven shock tunnel. The tunnel consists of a driver, driven tube and test section each separated by diaphragms. The high pressure developed in the driver tube ruptures the main diaphragm and the resultant shock wave compresses and heats the gas in the driven tube. The hot, pressurized gas expands through a nozzle into the test section housing the instrumented test model. The 22 foot long driver tube has an eight inch inside diameter and a design pressure of 10,000 psi. It is operated by the combustion of a gas mixture (20% hydrogen and 10% oxygen in helium) or by the charging of a single inert gas to pressure. The driven tube, six inches in diameter and composed of several interchangeable sections, is currently 92 feet long. The circular test section, six feet in diameter, is located behind a parallel flow contoured, axisymmetric expansion nozzle at the downstream end of the driven tube. This nozzle, 22 feet long, with a 54 inch exit diameter, has a nominal design Mach number of 20 with off-design potential down to Mach 9. The test section test core diameter is 24 to 40 inches.

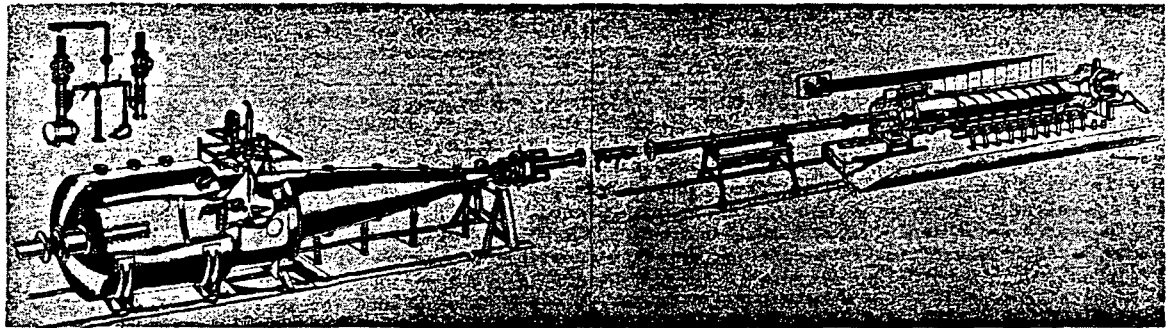
TESTING CAPABILITIES: The facility is capable of providing force and moment, surface pressure and heat transfer, and flow field property point measurement. Model mounting consists of either a sting type support, which is isolated from the tunnel structure, or a free flight system. Additional equipment includes a dual fluorescence probe for flow turbulence studies. Surface pressures are measured with piezoelectric sensors (measurement from .001 to 100 psi). Surface heat transfer measurements are accomplished with thin film thermometers and thick film calorimeters capable of from less than 1 to 10,000 Btu/sec-ft², also heat sensitive coating scorch patterns are available. Model boundary layer flow direction is studied with oil emulsion droplets which streak and "freeze". Schlieren, shadowgraph and sweeping electron beam optical systems are available. Data are recorded on magnetic tape and with oscilloscopes and reduced on site.

FACILITY COST HISTORY

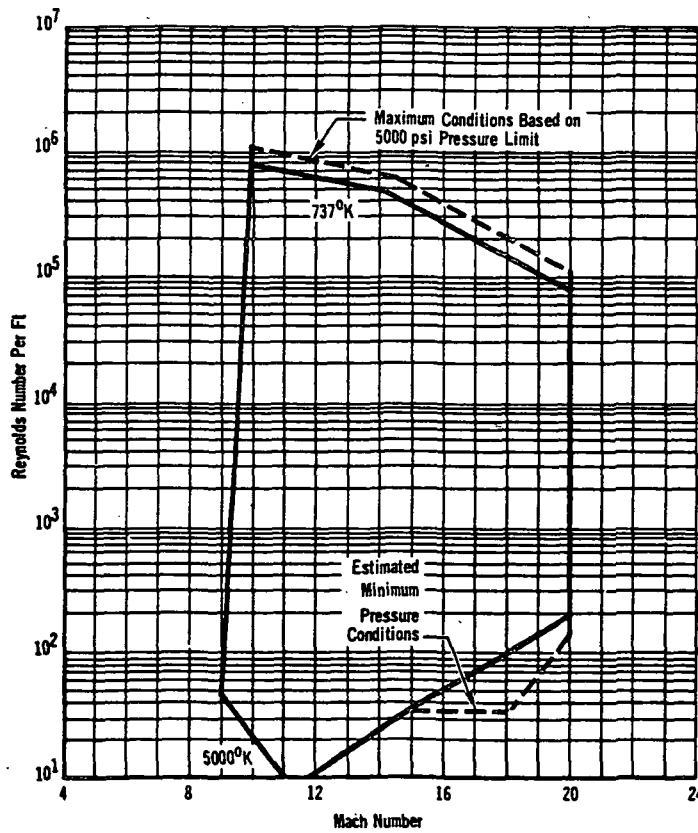
AVERAGE ESTIMATED OPERATING (Depends on test COST (TYPICAL 8 HOUR SHIFT): complexity)	CONSTRUCTION YEAR: 1956 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR:	LOCATION:
IMPROVEMENTS AND COSTS: (1965) Contoured nozzle, (1969) Dual Electron Beam (work studies)	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 9 to 20
 Reynolds Number ($\times 10^6/\text{ft}$): .00001 to 1
 Total Pressure (psia): Max 5000
 Dynamic Pressure (psf): Not Available
 Total Temperature ($^{\circ}\text{R}$): 2200 to 3200
 Run Time (milliseconds): 2 to 10

GENERAL ELECTRIC LONG TEST TIME HYPERSONIC FACILITY (LTF)

REPORTING INSTALLATION: General Electric Company P.O. Box 8555 Philadelphia, Pennsylvania 19101	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Re-entry and Environmental Systems Division
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (215) 962-3009

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is similar to a shock tunnel but operates on an adiabatic compression principle. It has a 16-foot heated reservoir tube and a two-foot diameter spherical driver. The parallel flow test nozzle has a 22 inch exit diameter and the test cabin has a diameter of 42 inches.

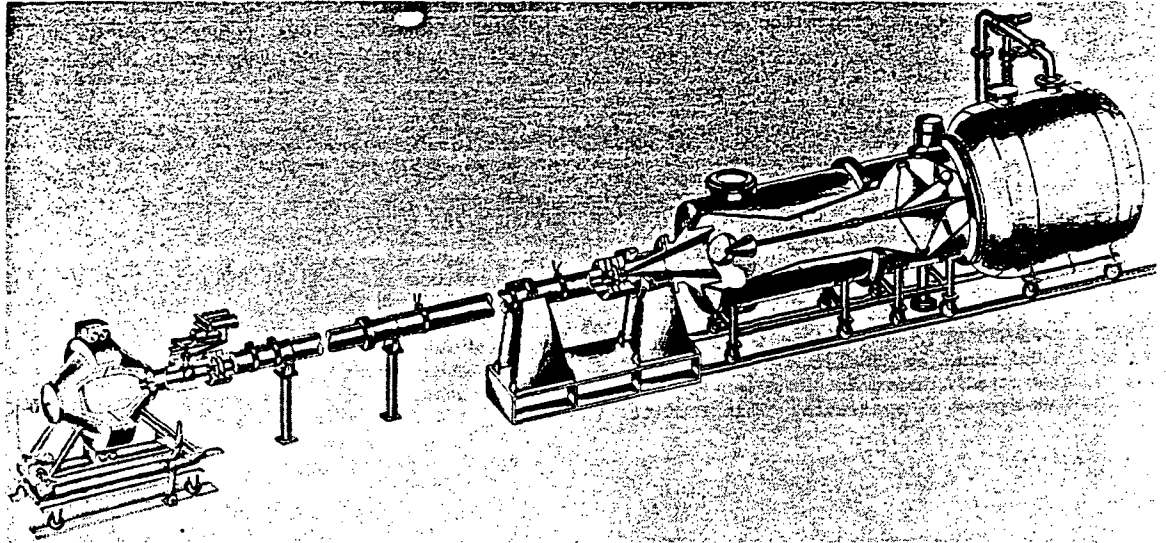
TESTING CAPABILITIES: This facility is used in application to research and development programs. The tunnel has sufficient test flow duration for the study of dynamic model motion as well as other fluid dynamic effects at Reynolds/Mach number conditions simulating hypersonic flight for re-entry vehicles not previously achievable in ground test facilities. Pressure measurements (piezoelectric transducers), surface heat transfer measurement (thin film and thick film calorimeter and resistance thermometers), forces and moments (including support-free model tests), and static density and species concentration (electron beam) tests may be run at this facility. Flow visualization can be obtained by schlieren, shadowgraph, luminosity and interferometric techniques. Data are recorded on magnetic tape and with oscilloscopes and reduced on site.

FACILITY COST HISTORY

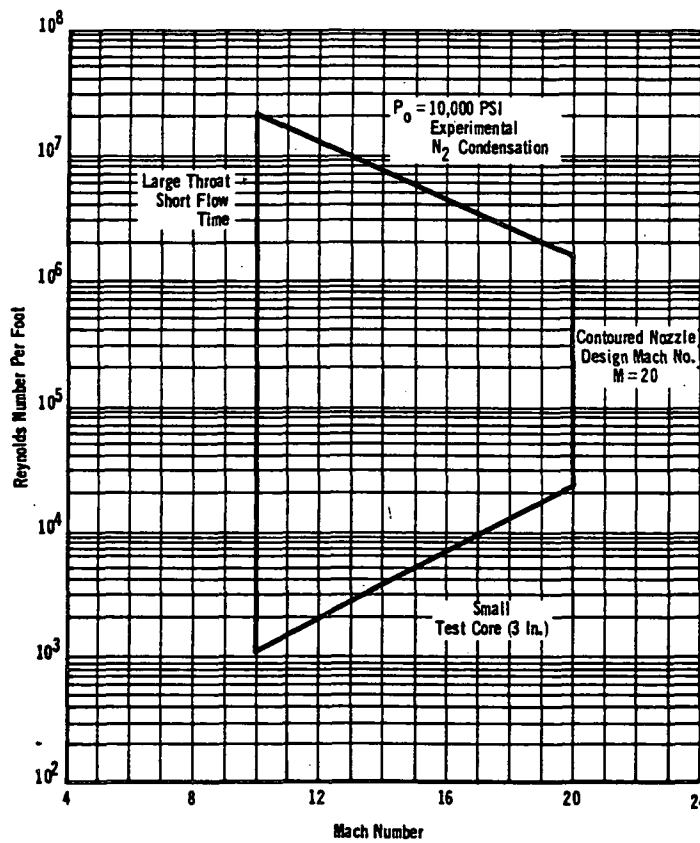
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Depends on test complexity	CONSTRUCTION YEAR: 1965 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: (1969) Contoured nozzle	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 10 to 20
 Reynolds Number ($\times 10^6/\text{ft}$): .001 to 20
 Total Pressure (psia): 2000 to 12000
 Dynamic Pressure (psf): Not Available
 Total Temperature ($^{\circ}\text{R}$): 2500
 Run Time (milliseconds): 15-40

GRUMMAN 36-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Grumman Aerospace Corporation Plant Number 5 Bethpage, L.I., New York 11714	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Test Section, Department 400
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (516) 575-7044

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to vacuum type tunnel. The test section is 36 inches in diameter with a 20 inch test core. High temperature air from a pebble bed heater is introduced to the test section through fixed contoured, axisymmetric nozzles.

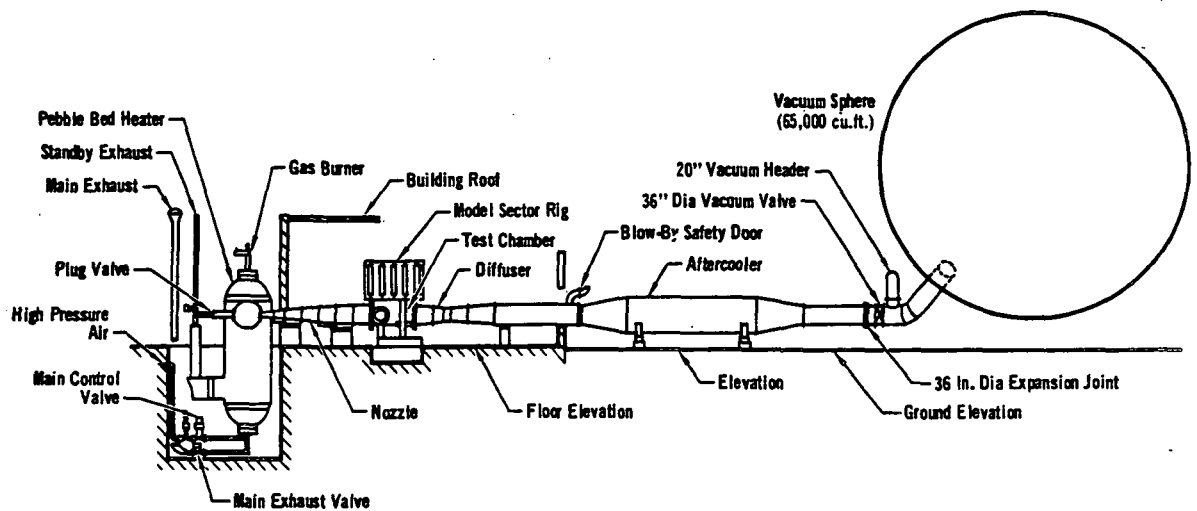
TESTING CAPABILITIES: This facility is capable of force and moment, pressure and heat transfer tests. Model mounting consists of a water-cooled, sting-balance sector rig which features a model injection system. Instrumentation for force, pressure, and heat transfer measurement is provided. A schlieren system is available. This facility is capable of 4 to 6 runs per day.

FACILITY COST HISTORY

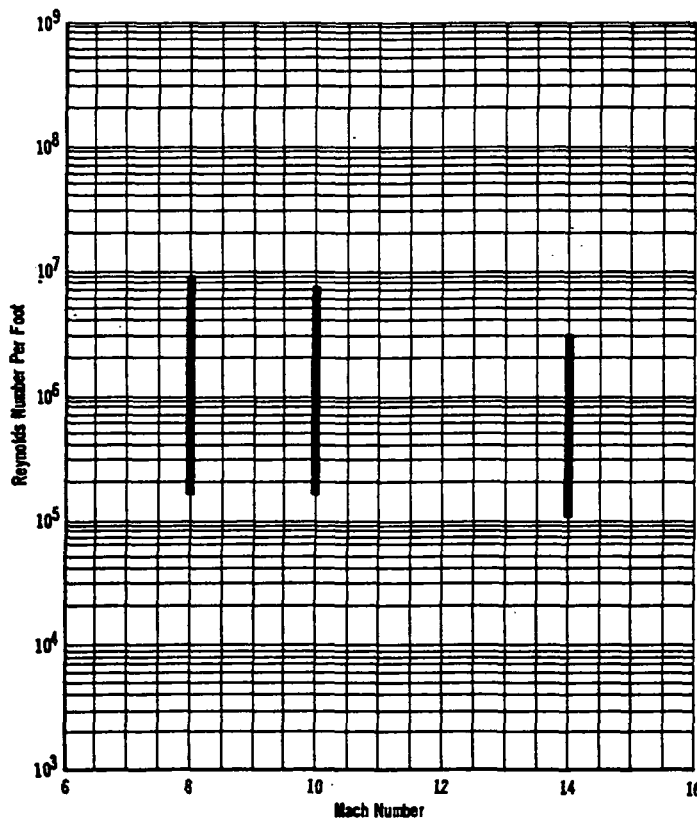
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2500	CONSTRUCTION YEAR: 1963 COST \$1,200,000 ESTIMATED REPLACEMENT VALUE \$2,000,000
CONTRACTOR: Walter Kidde, Chicago Bridge and Iron IMPROVEMENTS AND COSTS: (1964) Injection and pitch drive systems, Cost \$60,000; (1964) Air cooled plug valve, Cost \$5,000	LOCATION: (1964) Air cooled

PLANS FOR FACILITY IMPROVEMENTS: Adapter for second heater outlet to provide hot gas simulation testing. Improve working section diffuser. Pre-test cooler for model. Mach 6 nozzle.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	8, 10, 14
Reynolds Number ($\times 10^6$ /ft):	.2 to 4.5
Total Pressure (psia):	200 to 2200
Dynamic Pressure (psf):	100 to 1200
Total Temperature ($^{\circ}$ R):	1000 to 3500
Run Time (seconds):	30 to 60

GRUMMAN ROCKET PLUME SIMULATION FACILITY AND LOW ENERGY HYPERSONIC SHOCK TUNNEL

REPORTING INSTALLATION: Grumman Aerospace Corporation Plant Number 5 Bethpage, Long Island, New York 11714	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Research Department, Plant 35
OTHER SOURCES OF INFORMATION: Journal of Spacecraft and Rockets, Oct. 1968, p. 1148 and Grumman Research Dept. Report RE-217, June 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mr. Harold Hopkins or Mr. Jarvis Leng Phone: (516) 575-7044

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is basically an impulse shock tunnel, using a reflected detonation tube as the driven tube, geometrically scaled rocket nozzles instead of a hypersonic wind tunnel nozzle, and a 6-foot diameter vacuum chamber test section. The facility has the capability for overnight conversion to a low energy hypersonic shock tunnel. This mode of operation generates (in air) stagnation pressures up to 3000 psia, and a stagnation temperature of 3000°R. The flow is expanded through an 18-inch exit diameter conical nozzle to free stream Mach numbers between 10 and 15, with free stream Reynolds numbers per foot up to 1×10^6 at $M = 10$ and 4×10^5 at $M = 15$. The same instrumentation is available in this mode of operation as in the plume simulation mode.

TESTING CAPABILITIES: The primary function of this facility is to generate scale-model rocket plumes to measure plume impingement effects on space vehicles in a space environment. The facility is capable of simulating the full scale Reynolds number, total enthalpy, and chemical species present in the plumes of spacecraft rocket engines typical of the Apollo LM and CSM, at background pressure altitudes on the order of 500,000 ft. Up to 40 channels of surface heat transfer or pressure measurements can be obtained simultaneously. A 16-foot focal length schlieren system and self luminosity flow visualization is available with both high speed movies and single frame photography. Data reduction is manual. This facility is capable of two to five shots-per day.

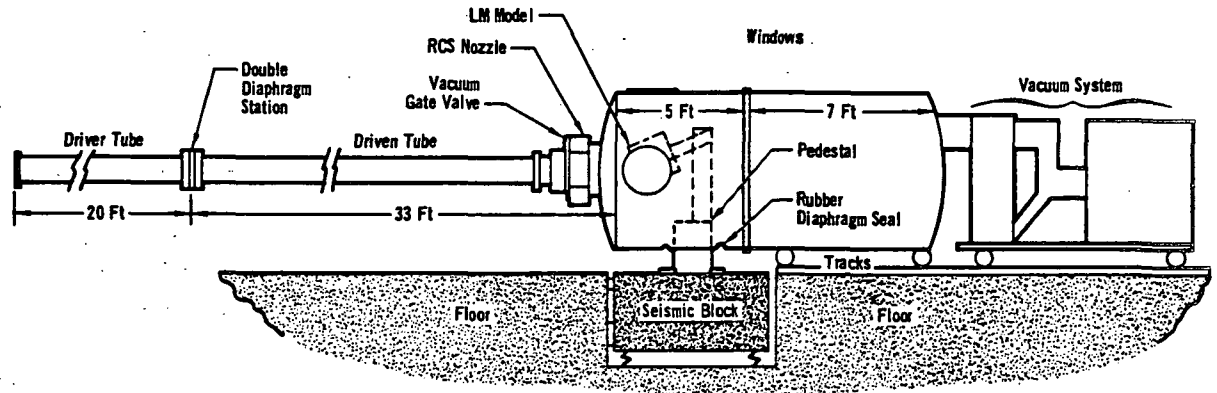
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$600	CONSTRUCTION YEAR: 1958 COST \$ 50,000 ESTIMATED REPLACEMENT VALUE \$400,000
CONTRACTOR: Built in-house	LOCATION: Bethpage, L.I., New York
IMPROVEMENTS AND COSTS: (1960-70)* Associated equipment and instrumentation, Cost \$100,000; (1966)* Six-foot diameter test section and vacuum system, Cost \$30,000.	

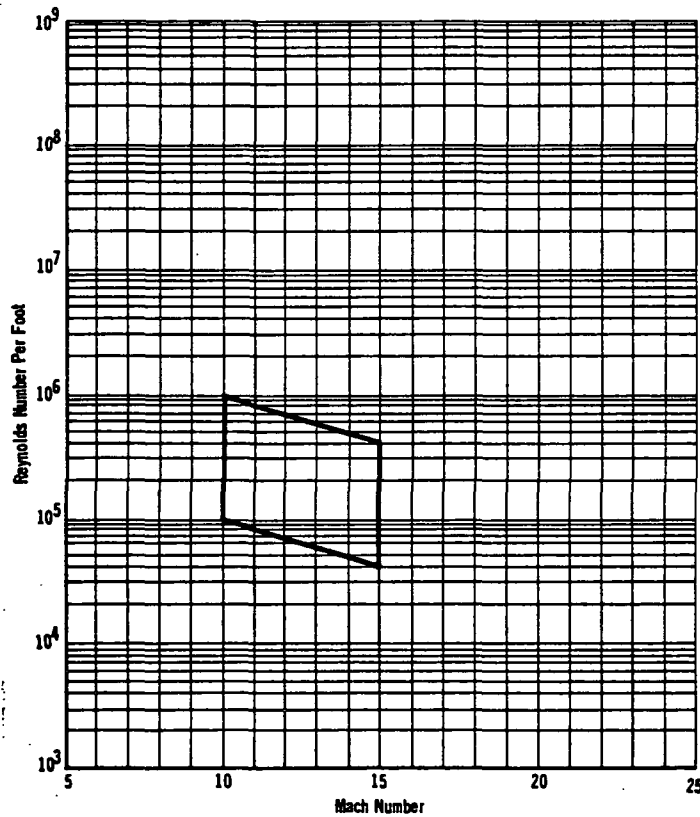
*Shared with 6-foot hypersonic shock tunnel. (Mothballed)

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 10 to 15
 Reynolds Number (x 10⁶/ft): .04 to 1
 Total Pressure (psia): 0 to 3000
 Dynamic Pressure (psf): Not Available
 Total Temperature (°R): To 3000
 Run Time (milliseconds): 2 to 5

KMS-TC 60-INCH HYPERVELOCITY TUNNEL IMPACT TEST FACILITY

REPORTING INSTALLATION: The KMS Technology Center A Division of KMS Industries, Inc. 7343 Deering Ave. Canoga Park, California 91303	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Re-entry Physics Department
OTHER SOURCES OF INFORMATION: Reports: Jet Propulsion, Vol. 28, No. 9, Sept. 1958; Journal of the Aerospace Sciences, Vol. 29, No. 12, Dec. 1962; WSS/CI Paper 62-2	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (213) 340-2707, 2998, 2999

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a 60-inch arc-driven hotshot tunnel utilizing a 100,000 joule capacitor. Four nozzles are available for this tunnel. The first, a 9° total angle conical nozzle with a 12-inch diameter free jet, has an isentropic core of approximately 9 inches in diameter. The second nozzle is a 16° total angle conical nozzle with a 21-inch diameter free jet and has an isentropic core of approximately 14.5 inches diameter. The 34-inch diameter free jet contoured nozzle has an isentropic core of approximately 28 inches diameter. The fourth nozzle, a 45° total angle conical nozzle with a 60-inch free jet, has an isentropic core of approximately 48 inches. Two types of drivers are available: an exponential decay steady flow driver, and a square wave unsteady flow driver.

TESTING CAPABILITIES: Simultaneous measurements are made of pressure, temperature, and density in stagnation chambers and behind normal shocks in the test section. Pressure distributions are measured by inertial pressure transducers to a 2 percent precision. This tunnel can be used to accelerate micro-particles to 70,000 ft/sec and study shock wave structure at initial air pressures of 20 microns Hg. Ballistic mounting of models has permitted lift, drag, and moment coefficients to be measured to 1 percent precision in gas dynamic to free molecule flow. Flow visualization is obtained by shadowgraph, schlieren, and self-luminosity equipment. Heat transfer rates can be measured at the hypervelocity tunnel over any complex surface in a range between 10 to 2000 watts/cm². The technique involves change of color of a special paint, calibrated by means of a series of spheres run at the same conditions as the model. This technique has been proven precise to plus or minus 5% on successive runs over any complex surface and has a minimum reading of .001 inches of surface length. This technique is the only one currently available to map heat transfer contours over complex surfaces as it is equivalent to the use of hundreds of millions of thermocouples on the usual model. Accuracy of data is plus or minus 15% due to theory used to reduce data. Flight test correlations is plus or minus 15% at Mach 8.0. In addition mass transfer heat transfer cooling schemes can be tested experimentally by turning on the mass transfer device before the tunnel and checking the heat transfer after the run. Amounts of cooling and point by point effectiveness of the cooling device is quantitatively available at any angle of attack on a model of any complexity. This technique has been used successfully on several programs in the entire flight simulation corridor of the hypervelocity tunnel. Since 1967 the 60-inch hypervelocity tunnel/impact test facility was equipped with light gas gun and a plasma-jet heater to facilitate performance of ablation/erosion experiments, as well as micrometeorite penetration studies and dust erosion investigations.

FACILITY COST HISTORY

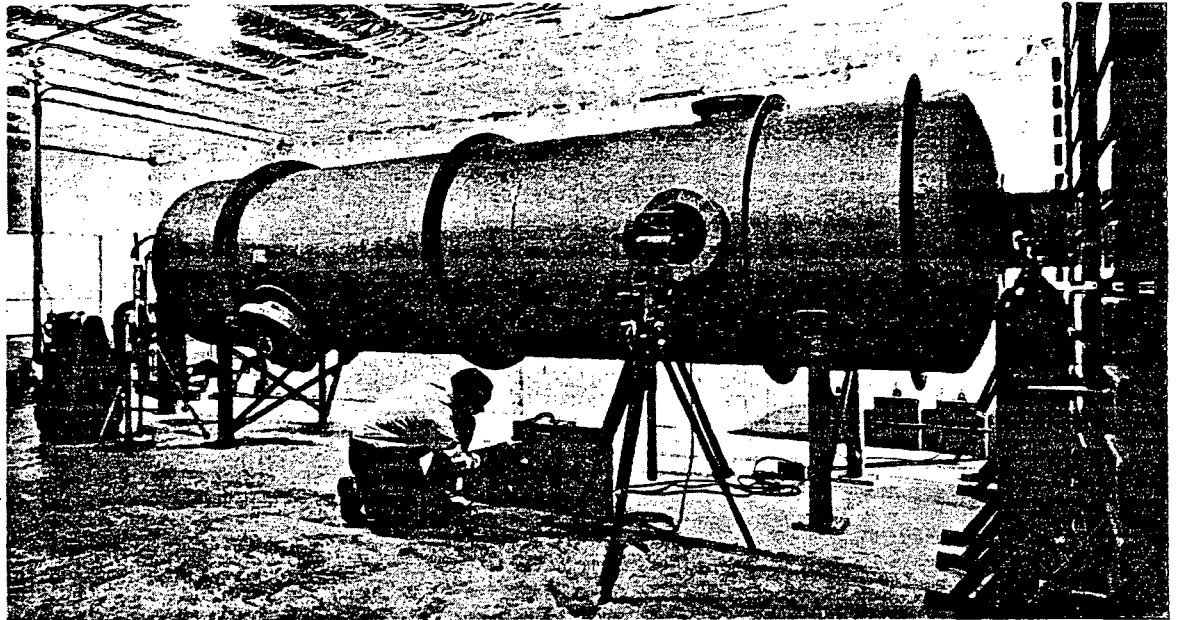
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$90/Specimen *	CONSTRUCTION YEAR: COST \$ 83,000 ESTIMATED REPLACEMENT VALUE \$141,500
CONTRACTOR: IMPROVEMENTS AND COSTS: (1968-70) Integration of multicycle capabilities for ablation/erosion experiments on real trajectory time basis, Cost \$250,000.	LOCATION: Canoga Park, California

* Only hypersonic experiments in groups of 25 specimens or more.

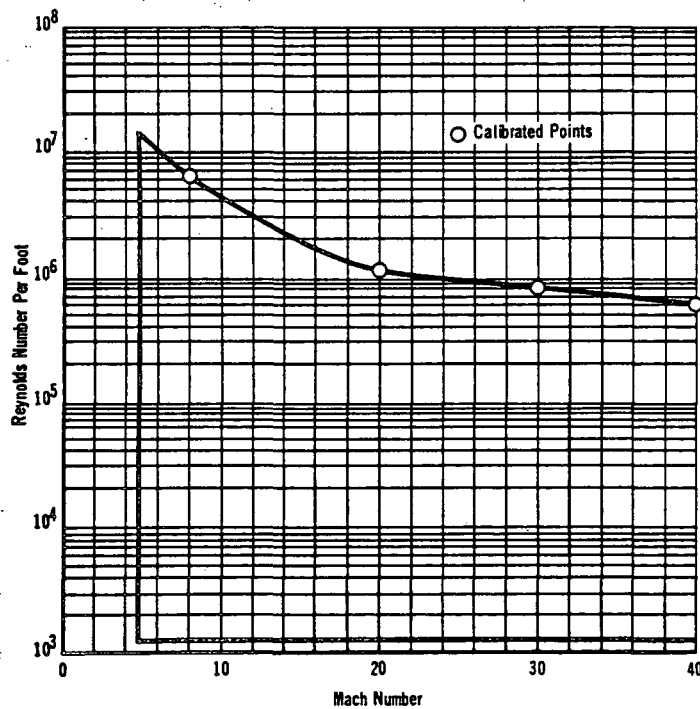
PLANS FOR FACILITY IMPROVEMENTS: Up-rating and instrumentation coverage, together with plasma-jet heater for simulation of aerodynamic heating and/or preheating.

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SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 5 to 40
 Reynolds Number ($\times 10^6/\text{ft}$): .0015 to 150
 Total Pressure (psia): 0 to 20,000
 Dynamic Pressure (psf): Not Available
 Total Temperature ($^{\circ}\text{R}$): 500 to 80,000
 Run Time (milliseconds): .05 to 2

LTV VAD HYPERVELOCITY WIND TUNNEL

REPORTING INSTALLATION: LTV Aerospace Corporation P.O. Box 5907 Dallas, Texas 75222	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Vought Aeronautics Division
OTHER SOURCES OF INFORMATION: Summary of the Long Run Time Hypervelocity Wind Tunnel (a new handbook is scheduled in late 1970).	LOCAL OFFICE TO CONTACT FOR INFORMATION: Gas Dynamics Laboratories Phone: (214) 266-3234

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is a deviation of an electrical arc discharge facility. The deviation of this tunnel from the conventional arc discharge facility is the incorporation of a unique variable volume arc chamber (Patent No. 3,418,445, assigned to LTV Aerospace Corporation) which allows the tunnel to operate at constant flow conditions during a run while providing longer useable run time in comparison to a conventional arc heated tunnel. A specially designed quick-opening valve is situated at the nozzle inlet and has proved most effective in reducing contamination and preventing model damage from any residue originating in the arc chamber. The test section is 13 inches in diameter with a nominal 5-inch test core. The nitrogen test medium is expanded in a 7.5°-total-included-angle nozzle. The energy for the arc is supplied by a capacitor bank capable of storing 265,000 joules when charged to 6000 volts. A modification (completed July 1970) will expand the tunnel performance envelope to allow testing at lower Mach numbers and higher Reynolds numbers while increasing the run time for conditions in the present envelope. This modification will employ the variable volume feature and will provide a larger arc chamber (.17 cu ft), increased energy (650,000 joules), and contoured nozzles for operation at Mach numbers of 8 and 12 with test core diameters of 6 inches.

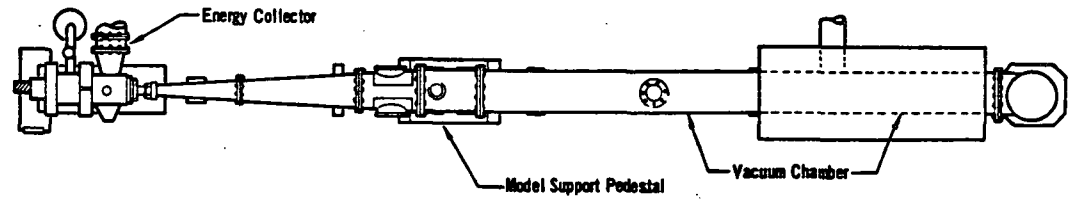
TESTING CAPABILITIES: Force, pressure, heat transfer and dynamic stability tests have been successfully conducted in this facility. These tests have been performed with special models for the simulation of ablation (or transpiration cooling) and rocket exhaust. The facility has developed specialized equipment and techniques for tests with porous skin models. Models are mounted on a sting which is secured to a crescent having a center of rotation near the center of two 10-inch diameter windows. The angle of attack can be varied in 1° increments to + 11°. Higher angles are available with adapters. A double-pass schlieren system is available for flow visualization studies using either still photography or high speed motion picture coverage. The data are acquired in digital form by an IBM 1800 Digital Computer located on-site. This machine is also used for data reduction. Data traces are recorded on an oscillograph for a qualitative post-run inspection of the results. This facility is capable of three shots per day.

FACILITY COST HISTORY

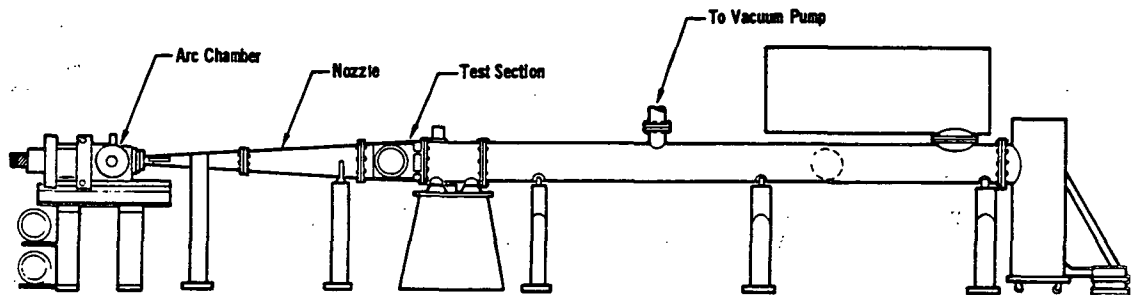
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1650	CONSTRUCTION YEAR: 1959 COST \$100,000 ESTIMATED REPLACEMENT VALUE \$300,000
CONTRACTOR: LTV Aerospace Corp. LOCATION: Dallas, Texas IMPROVEMENTS AND COSTS: (1962) Building improvements, Cost \$20,000; (1964) Added variable volume arc chamber, Cost \$50,000; (1969) Digital data acquisition and on site data reduction, (Rental); (1969) Increase energy and arc chamber for Mach 8-12 capability, Cost \$100,000.	

PLANS FOR FACILITY IMPROVEMENTS: The Mach 8-12 modification will be completed by mid-1970. Future long range plans include contoured nozzles for other Mach numbers and increased energy storage. The facility is available for rental at a fixed rate per run.

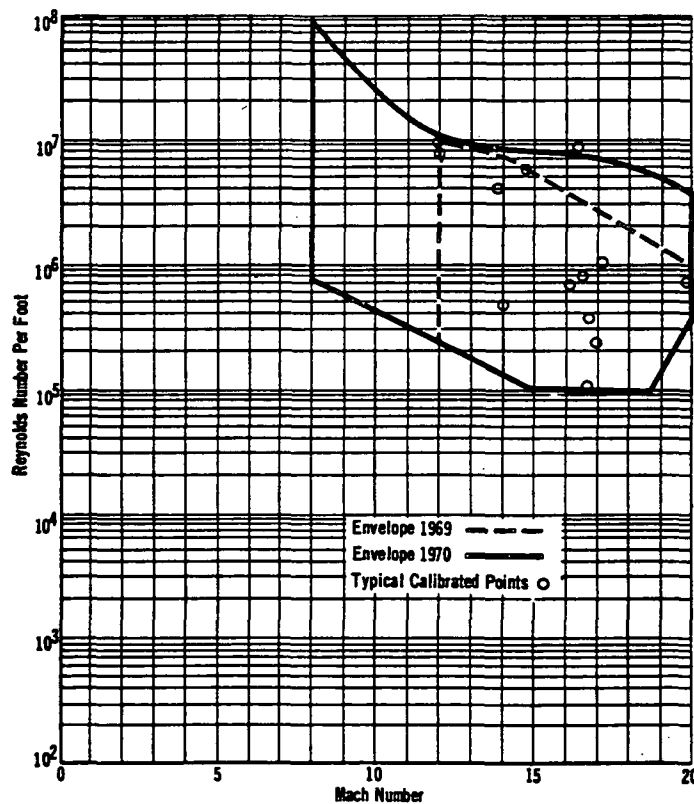
SCHEMATIC



1969
Prior to Modification



FACILITY PERFORMANCE DATA



Mach Range:	12 to 20
Reynolds Number ($\times 10^6/\text{ft}$):	.1 to 7
Total Pressure (psia):	6000 to 25,000
Dynamic Pressure (psf):	16 to 2000
Total Temperature ($^{\circ}\text{R}$):	2700 to 8100
Run Time (milliseconds):	30 to 300

LOCKHEED-CALIFORNIA HYPERVELOCITY SHOCK TUNNEL

REPORTING INSTALLATION: Lockheed-California Company P. O. Box 551 Burbank, California 91503	STATUS OF FACILITY: Inactive COGNIZANT ORGANIZATIONAL COMPONENT: Fluid Dynamics Laboratory Rye Canyon, California
OTHER SOURCES OF INFORMATION: Lockheed "Advanced Fluid Dynamics Facilities", November 1963	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (213) 847-6121

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a helium driven, single-stage reflected type shock tunnel. The driver section is 20 feet in length with an 8 inch i.d. The driven section is 40 feet in length with a 6 inch i.d. An electric resistance heater arranged internally is capable of heating the driver gas to approximately 1160°R. The expansion nozzle is an axially symmetric cone having 30° included angle. The maximum test section diameter is 110 inches.

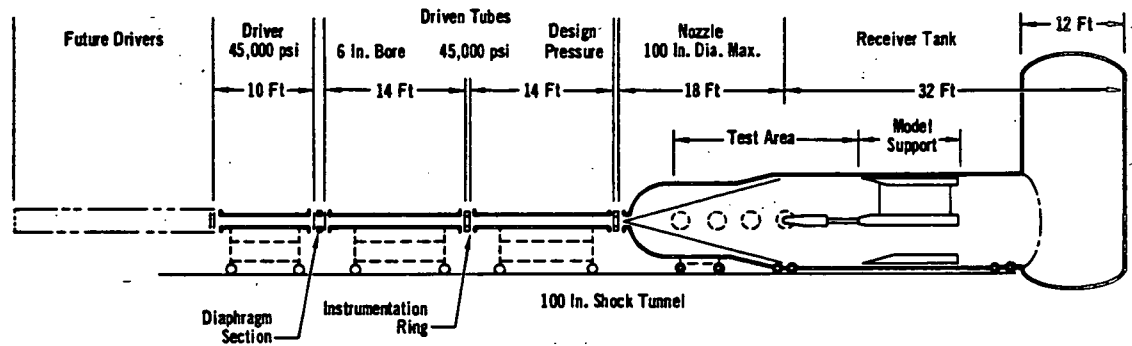
TESTING CAPABILITIES: The model support sting mount is of the free pendulum type. A 7000 lb steel billet suspended from the ceiling of a diffuser section ensures vibration isolation for the sting mounted instrumentations. The diffuser section being enclosed within the dump tank and supported on rollers can be moved back and forth to facilitate axial positioning of the model with respect to the fixed nozzle location. Data are recorded on oscilloscopes with camera attachments. Data are reduced on an SDS 930 computer system.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ Not Available ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

Operating Envelope

(Not Available)

Mach Range:	9 to 25
Reynolds Number ($\times 10^6/\text{ft}$):	Not Available
Total Pressure (psia):	0 to 45,000
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	Not Available
Run Time (milliseconds):	0 to 10

LOCKHEED-CALIFORNIA 30-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Lockheed-California Company P. O. Box 551 Burbank, California 91503	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Fluid Dynamics Laboratory Rye Canyon, California
OTHER SOURCES OF INFORMATION: Lockheed "Advanced Fluid Dynamics Facilities", November 1963	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (213) 847-6121

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to exhaust system type tunnel. The tunnel has an open jet type test section. The tunnel is equipped with a water cooled nozzle and diffuser. Air flow pressure and temperature is controlled by automatic regulators in the air supply system. This facility uses common air supply and exhaust system, which is shared by a 100 inch shock tunnel and a propulsion tunnel.

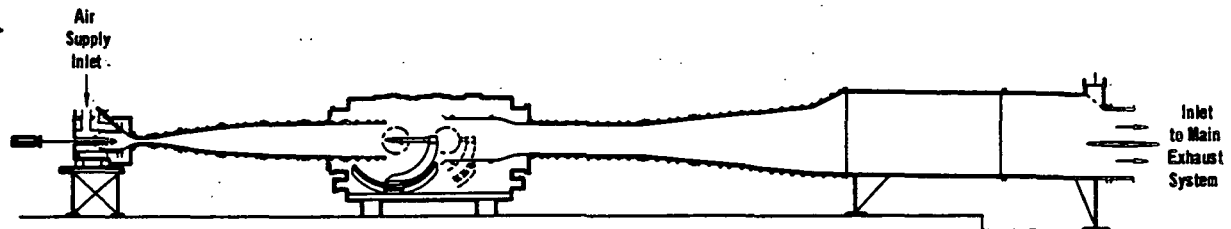
TESTING CAPABILITIES: Model mounting consists of a water cooled sting sector type support. Due to the running time, remote manual sequencing of model attitude is provided. Models are water cooled. Aero-dynamic and aerothermal tests are conducted at this facility. Data are recorded on 52 channels with a custom version of the Beckman Model 210. Data are reduced on an SDS 930 computer system.

FACILITY COST HISTORY

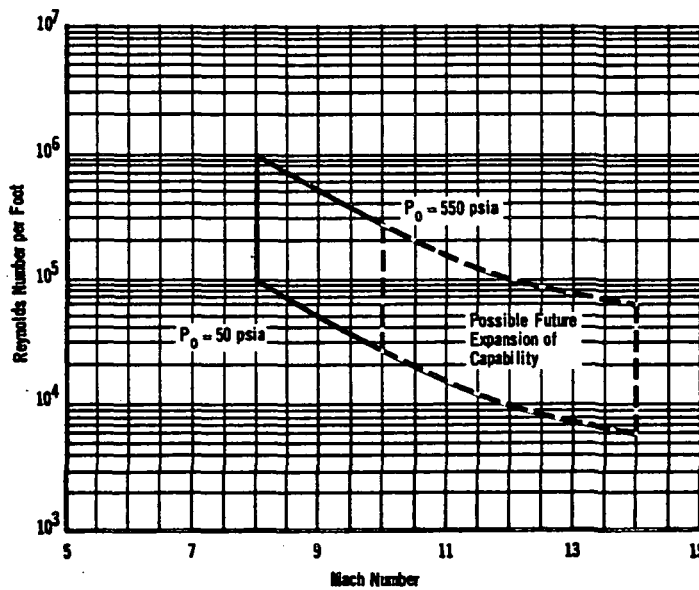
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: COST \$ Not Available ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	8 and 10
Reynolds Number ($\times 10^6/\text{ft}$):	.0006 to 1
Total Pressure (psia):	50 to 550
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	1260 to 1660
Run Time (minutes):	3 to 5

MCDONNELL DOUGLAS HYPERVELOCITY IMPULSE TUNNEL

REPORTING INSTALLATION: McDonnell Douglas Corporation McDonnell Aircraft Company P.O. Box 516 St. Louis, Missouri 63166	STATUS OF FACILITY: Mothballed COGNIZANT ORGANIZATIONAL COMPONENT: General Engineering Division Gas Dynamics Laboratory (Dept 254)
OTHER SOURCES OF INFORMATION: AIAA Paper No. 66-757	LOCAL OFFICE TO CONTACT FOR INFORMATION: Gas Dynamics Laboratory McDonnell Aircraft, St. Louis Phone: (314) 232-5331

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is an electric arc driven impulse facility of the "hotshot" type. A capacitor bank system provides up to 7,000,000 joules to the test gas, normally nitrogen stored under pressure in the arc chamber. The test gas volume is .52 cubic feet at a maximum pressure of 30,000 psia. Parallel flow from M = 11.5 to 17.0 is developed by a 40-inch diameter contoured nozzle. Mach numbers up to 24 are obtained in a 44-inch diameter conical nozzle. An open-jet test section is used with a test cart of approximately 23-inches.

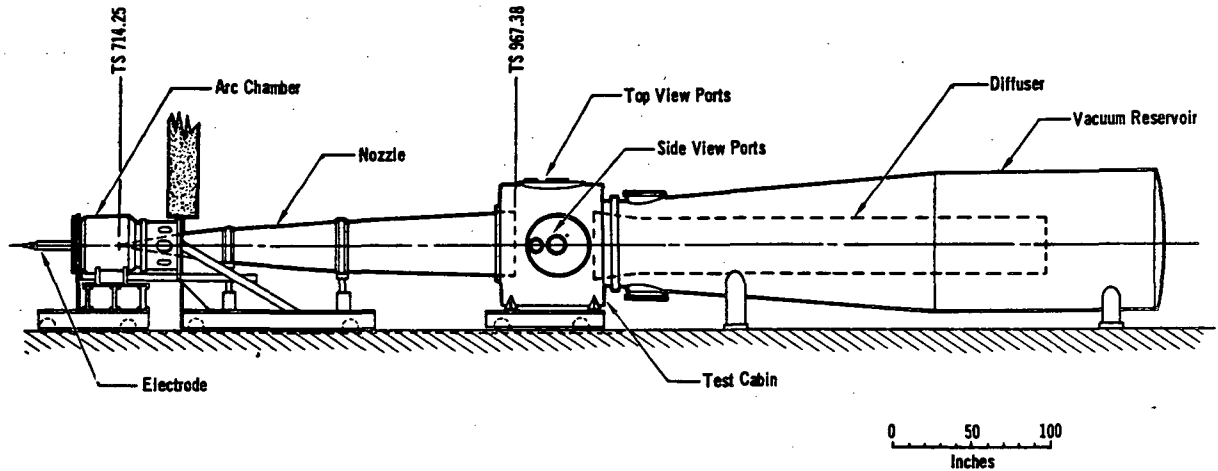
TESTING CAPABILITIES: This tunnel is capable of force and moment, pressure, heat transfer, hinge moment and thermographic mapping tests. The models are supported by a sting with fixed and variable angle of attack capability during very short run times. A ten inch schlieren system is available with both still and motion picture flow visualization recording. A Honeywell Analog Tape Recorder (60 channels) records the data which is reduced using an off site IBM 360/75 computer.

FACILITY COST HISTORY

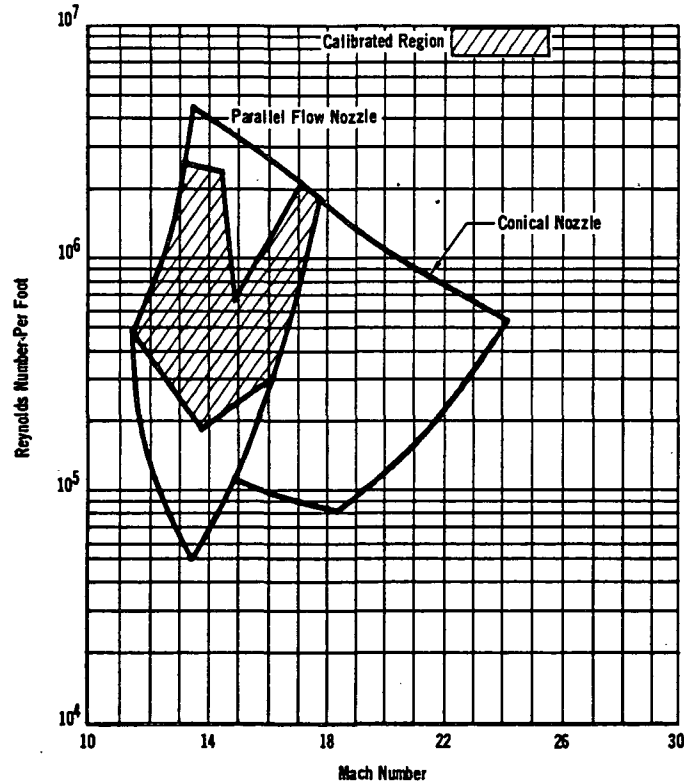
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$800	CONSTRUCTION YEAR: 1959 COST \$ 967,000 ESTIMATED REPLACEMENT VALUE \$2,250,000
CONTRACTOR: Nooter Corp.; McDonnell Aircraft Co. LOCATION: St. Louis, Missouri (Both) IMPROVEMENTS AND COSTS: (1963) 60 Channel Analog Tape Recorder (Honeywell), Cost \$110,000; (1964) Contoured nozzle and flow straightener, Cost \$100,000 (est); (1965) Arc chamber, Cost \$61,000; (1966) Photographic temperature mapping, Cost \$23,000; Others, Cost \$41,000 (est).	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	11.5 to 24
Reynolds Number ($\times 10^6/\text{ft}$):	.05 to 4.3
Total Pressure (psia):	To 30,000
Dynamic Pressure (psf):	To 1700
Total Temperature ($^{\circ}\text{R}$):	To 7820
Run Time (milliseconds):	Approx. 140

MCDONNELL DOUGLAS 30-INCH HYPERVELOCITY SHOCK TUNNEL

REPORTING INSTALLATION: McDonnell Douglas Corporation McDonnell Douglas Astronautics 3000 Ocean Park Blvd. Santa Monica, California 90406	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Engineering Laboratories
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Douglas Aerophysics Laboratory El Segundo, California Phone: (213) 322-1140

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a shock tunnel which incorporates a shock tube to process the test gas to a high pressure, high enthalpy state. The driver tube is 22 feet 4 inches long and has a 7-inch i.d. and a 14-inch o.d. A cold or heated gas driver technique is utilized. Nitrogen, helium or a combination of these gases can be used as a driver gas. The driven tube is 39 feet 9.75 inches long and has a 5-inch i.d. There are two nozzles available for use in the tunnel. One nozzle is conical with a total expansion angle of 10 degrees and an exit diameter of 30-inches with interchangeable nozzle throats. The second nozzle is a contoured axisymmetric nozzle with an exit diameter of 28.86 inches. The nominal operational Mach number of this nozzle is 8. The test section consists of a 31.5-inch external diameter cylinder 30.4 inches long. The internal surface of the cylinder is contoured by extending the contoured nozzle contour. Two 11.25-inch diameter side windows are located 9.4 inches aft of the nozzle exit for model viewing. Top and bottom model viewing is made available through two 11.25-inch diameter windows located 15 inches aft of the nozzle exit. The test section is connected to the model support and diffuser section. The vertical strut spans the full diameter of this section and has 36 bolt holes for positioning the model. The test section is 30 inches in diameter with a 26-inch test core. The driver gas volume is 5.97 cu ft with maximum pressure of 27,000 psia and the test gas volume is 5.86 cu ft with a maximum pressure of 500 psia.

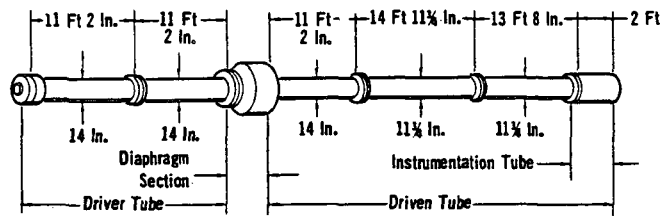
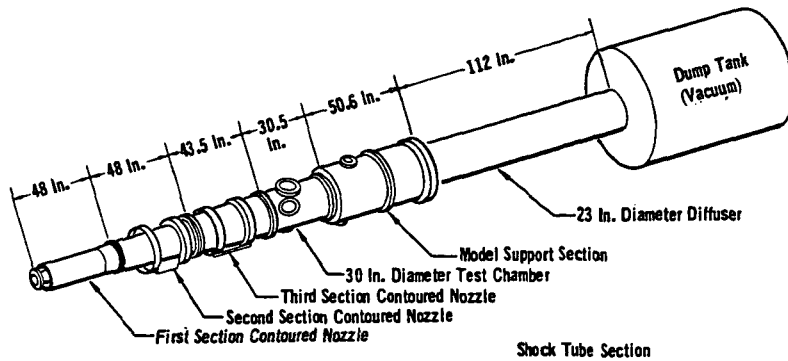
TESTING CAPABILITIES: This facility is capable of force, pressure and heat transfer measurements. Model mounting consists of fixed angle sting and strut type supports. A double-pass schlieren system is used for flow visualization. Data are recorded on 100 channels and reduced with an on site Xerox Data System (XDS) 930 computer. Tests involving external burning can be made at this facility.

FACILITY COST HISTORY

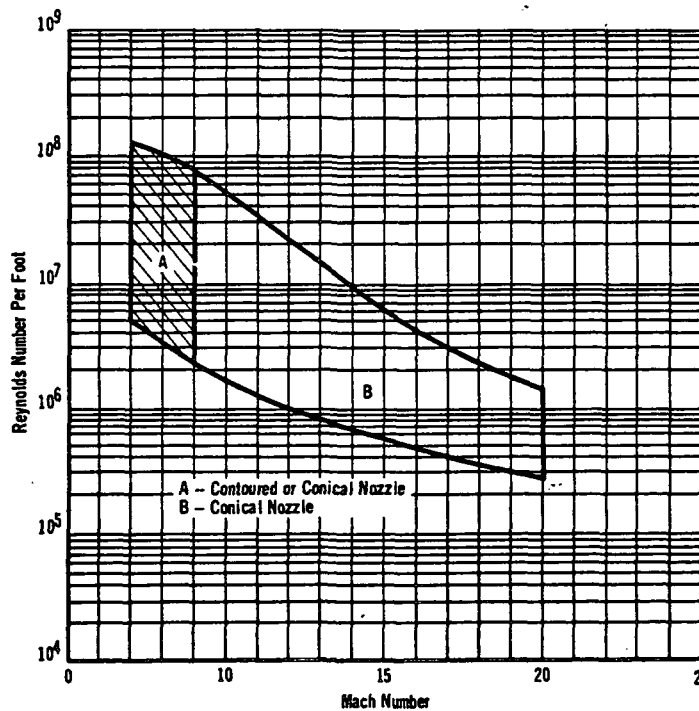
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2500	CONSTRUCTION YEAR: 1961 COST \$ 368,000 ESTIMATED REPLACEMENT VALUE \$1,000,000
CONTRACTOR: Bovee and Crail Construction Company	LOCATION: Los Angeles, California
IMPROVEMENTS AND COSTS: (1966) Upgrade shock tube and compressors to 30,000 psi hydrogen driver, Cost \$180,000; (1969) Contoured Mach 8 nozzle, Cost \$64,000; (1969) Floating model support and new test section, Cost \$50,000.	

-PLANS FOR FACILITY IMPROVEMENTS: Throat valve, shuts flow off at end of run.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	7 to 20
Reynolds Number ($\times 10^6/\text{ft}$):	.26 to 130
Total Pressure (psia):	11,000 to 25,000
Dynamic Pressure (psf):	100 to 49,000
Total Temperature ($^{\circ}\text{R}$):	2000 to 6000
Run Time (milliseconds):	7

MCDONNELL DOUGLAS 2-FOOT HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: McDonnell Douglas Corporation McDonnell Douglas Astronautics 3000 Ocean Park Blvd. Santa Monica, California 90406	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Engineering Laboratories
OTHER SOURCES OF INFORMATION: The Douglas Aerophysics Laboratory 2-Foot Hypersonic Wind Tunnel, Douglas Report DAC-59808, October 1967	LOCAL OFFICE TO CONTACT FOR INFORMATION: Douglas Aerophysics Laboratory El Segundo, California Phone: (213) 322-1140

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to vacuum type facility using an air-driven ejector system to obtain the downstream vacuum. The test section is a 2-foot diameter open jet with nominally an 18-inch diameter by 36-inch length test core. Tunnel air is stored at a maximum pressure of 3500 psia in two tanks having a combined capacity of 500 cubic feet. In order to attain desired stagnation temperature levels, an appropriate amount of air is heated by passing it through a natural gas fired pebble bed heater. Tunnel air is stored in the tanks and pebble bed heater. Mach 6, 8 and 10 axisymmetric, contoured, fixed Mach number nozzles are used. The tunnel's variable and fixed diffusers and the ejector system are all water cooled.

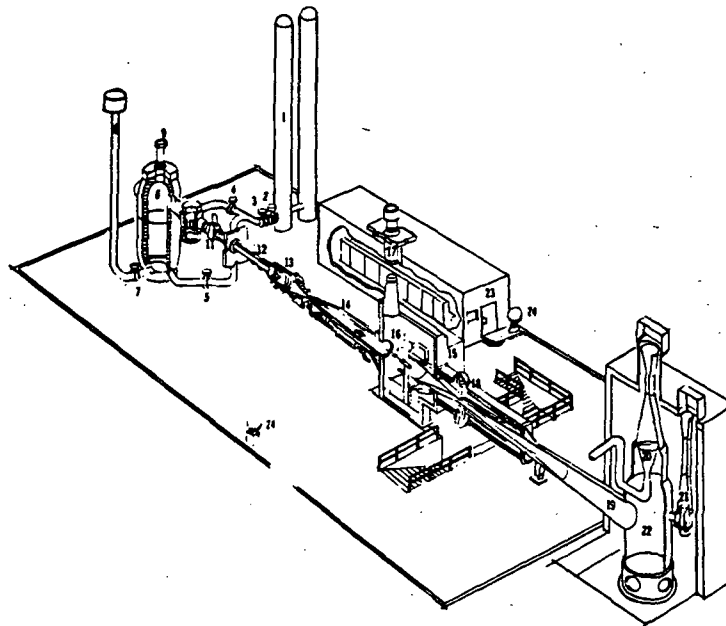
TESTING CAPABILITIES: This tunnel is capable of force and moment, ablation, pressure, heat transfer, internal duct flow, rocket effects (hot or cold), and panel flutter tests. Models are sting and strut mounted. Model pitch attitude is effected through either a pitch-pause mode of operation (maximum of 16 pre-set angles) or a pitch-sweep mode of operation (sweep rate adjustable in the range 0 to 12 degrees per second). A remote roll mechanism is available to control roll attitude. An injection system is also available. Schlieren and shadowgraph systems are used for flow visualization. Data are recorded using 32 channels (192 multiblock mode) and reduced on a Xerox Data System (XDS) 930 computer, which is on site. Data tabulations and plots are available within a few minutes of the completion of a run. The average run-rate for the facility is 14 runs per 8 hour day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$6000	CONSTRUCTION YEAR: 1961 COST \$2,500,000 ESTIMATED REPLACEMENT VALUE \$4,000,000
CONTRACTOR: Diversified Builders	LOCATION: Los Angeles, California
IMPROVEMENTS AND COSTS: (1965) Model heat shield, Cost \$10,000.	

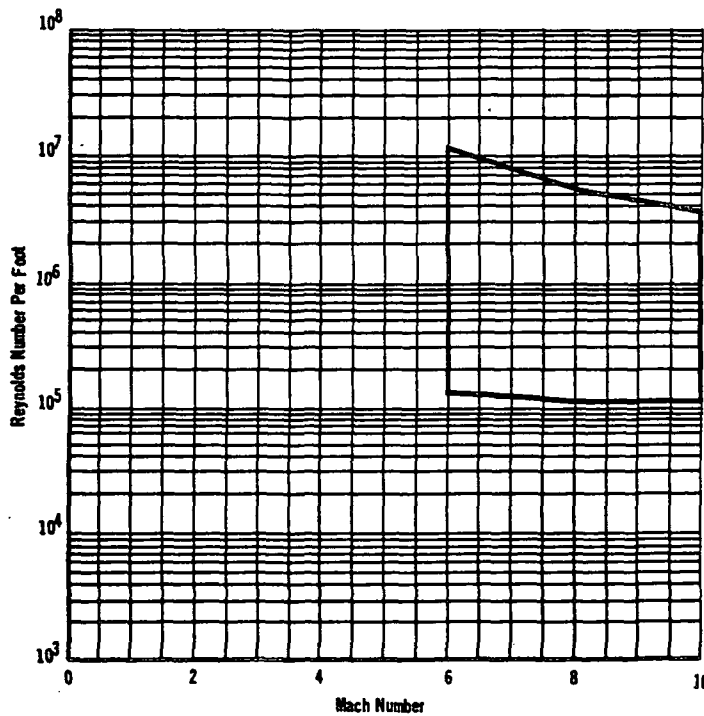
PLANS FOR FACILITY IMPROVEMENTS: None.

SCHMATIC



1. Air Storage Tanks
2. Main Air Gate Valve
3. Pressure Control Valve
4. Temperature Control Valve
5. Differential Pressure Valve
6. Pebble Bed Heater
7. Heater Stack Valve
8. Heater Stack
9. Heater Burner
10. Thermal Mixer
11. Hot Shut-Off Valve
12. Interchangeable Spool
13. Settling Chamber
14. Interchangeable Nozzle
15. Test Cabin
16. Model Support
17. Test Cabin Pressure Relief Valve
18. Variable Diffuser
19. Fixed Diffuser
20. Main Ejector
21. Side Ejector (Typical 4 Places)
22. Ejector Evacuated Chamber
23. Control Room
24. Schlieren Mirrors (Light Source and Camera not Shown)

FACILITY PERFORMANCE DATA



Mach Range:	6, 8, 10
Reynolds Number ($\times 10^6/\text{ft}$):	1.2 to 12
Total Pressure (psia):	250 to 2250
Dynamic Pressure (psf):	288 to 1440
Total Temperature ($^{\circ}\text{R}$):	850 to 2470
Available Run Time (sec):	85 to 110
Recycle Time (minutes):	30

NASA AMES 42-INCH SHOCK TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Fluid Mechanics Branch
OTHER SOURCES OF INFORMATION: Report Nos. TMX-1691; TND-4985; TND-5526	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mail Stop N-229-4 Phone: (415) 961-1111, ext 2545

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The facility is a combustion-driven shock tunnel operating with a reflected-shock reservoir of test gas. A unique, large volume combustion chamber provides an unusually long period of quasi-steady reservoir conditions in any of a variety of planetary gas mixtures. A closed, hexagonal test section joins to a 20° conical nozzle with a 42-inch exit diameter. A smaller conical nozzle and a contoured nozzle are being developed. The facility is also operated with a cold-helium driver. The test section is 3.5 by 3.5 x 6-feet with a 16 to 32 inch test core. The test gas volume is .2 to .5 cu ft at 7500 psia and the driver gas volume is 86 cu ft at 5000 psia.

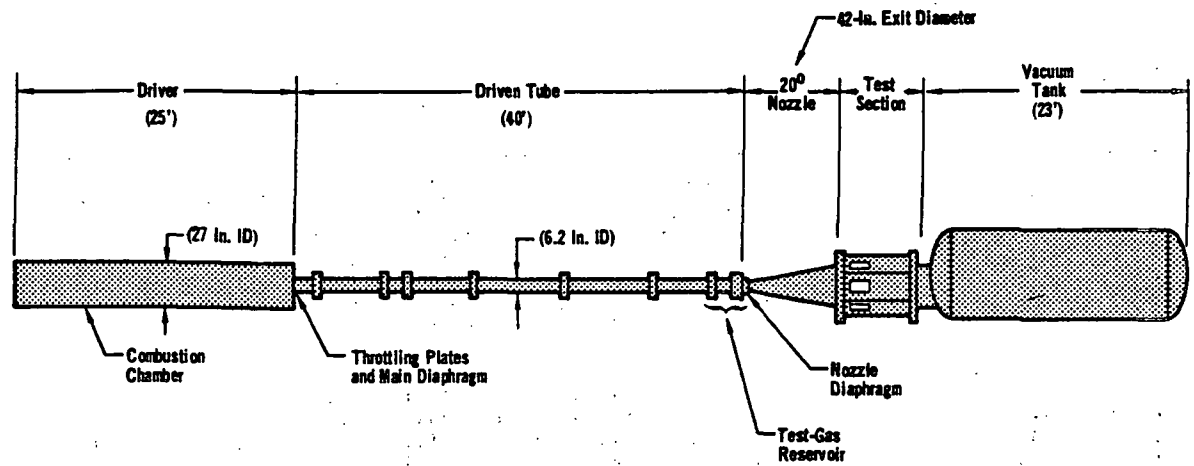
TESTING CAPABILITIES: Fixed models are used for pressure, heat transfer, shock wave interaction, and surface flow direction tests over a wide range of stream conditions, including substantial low-density and real-gas effects. Forces and moments are measured with free-falling models initially supported by filaments or by a retracting table; telemetering techniques are used for measuring support-free pressures and heat transfer. Photographic recording methods have been developed for precise evaluation of model motion. An interferometer schlieren system is under development. Data can be recorded (36 channels) in analog form on high-speed oscillographs or in digital form on a unique, 500,000 sample per second recorder, and reduced off site with a 7040/7094 digital computing system. This facility is capable of one shot per day.

FACILITY COST HISTORY

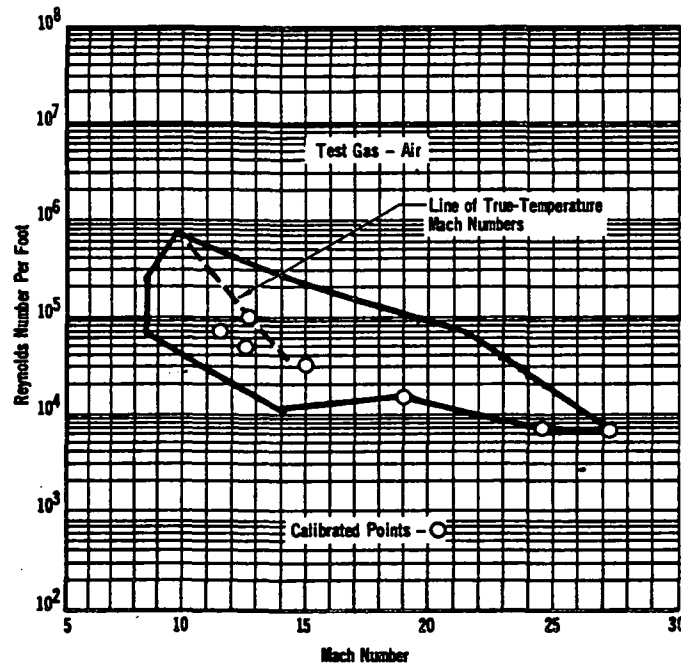
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1949 COST \$ 131,000 ESTIMATED REPLACEMENT VALUE \$3,195,000
CONTRACTOR: In-House and Small Contracts	LOCATION:
IMPROVEMENTS AND COSTS: (1950-53) Wind tunnel calibration, strain gauge balance, Cost \$528,000; (1954-57) Readout system, piping modfn., Cost \$75,000; (1958-61) Cooling system, W.T. alteration, mod. to entry simlr., Cost \$627,000; (1962-65) Mod. to gas mixture control system, calibration of entry simulator, Cost \$107,000; (1966-69) Test section; Others, Cost \$624,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 8.5 to 27.2
 Reynolds Number ($\times 10^6/\text{ft}$): .007 to .7
 Total Pressure (psia): 2000 to 7500
 Dynamic Pressure (psf): 4 to 120
 Total Temperature ($^{\circ}\text{R}$): 6000 to 12,000
 Run Time (seconds): .015

NASA AMES 3.5-FOOT HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Hypersonic Aerodynamics Branch
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mail Stop N-229-1 Phone: (415) 961-1111

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is an intermittent blowdown to vacuum type tunnel. The test section is 3.5-foot in diameter, of the closed type, and can accommodate models up to 24-inches in span, 40-inches in length and 10-inches in diameter. The test core is 22-inches in diameter at $M = 10$. Four axisymmetric contoured nozzles utilizing helium film cooling to control wall temperature are used to generate tunnel Mach numbers. A high purity alumina pebble bed type heater is used in this facility.

TESTING CAPABILITIES: This facility is capable of force and moment, pressure, and heat transfer type tests. The tunnel can accommodate models up to 24-inches in span, 40-inches in length and 10-inches in diameter on straight or bent sting supports. A quick-inserting strut is available to insert models into the test stream that will accommodate models to 17-inches in span and 24-inches in length. Insertion time is approximately 1/2-second. Data recording is on magnetic tape, at rates to 2500 samples per second, and reduced off site on an IBM 7094 system. This facility is capable of four runs per day.

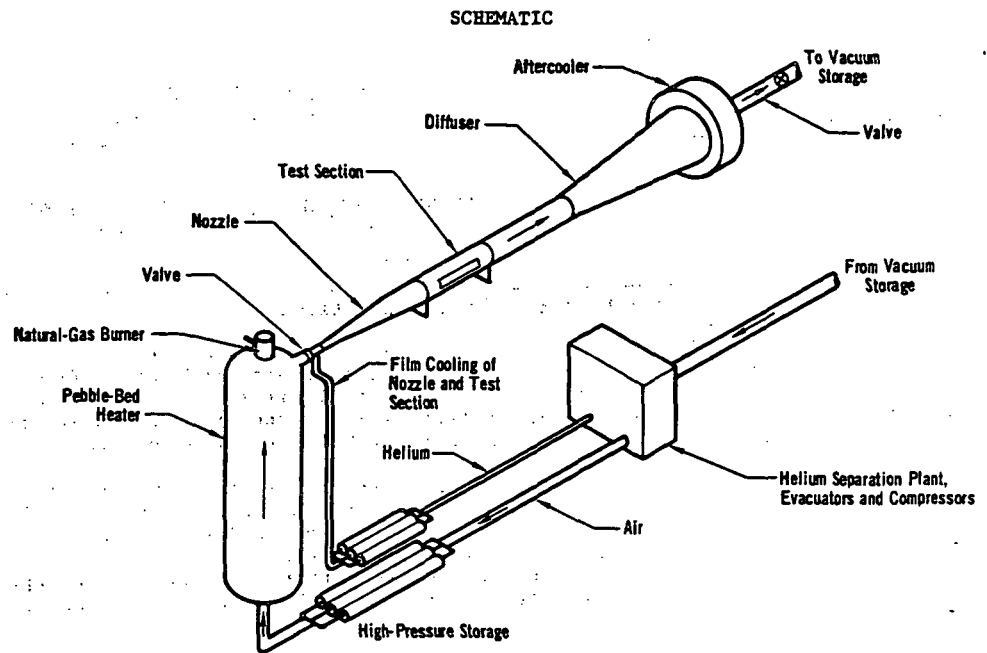
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$5000*	CONSTRUCTION YEAR: 1961 COST \$10,531,000 ESTIMATED REPLACEMENT VALUE \$19,111,000
CONTRACTOR: Babcock & Wilson, Inc.; Kaiser Engineers LOCATION: IMPROVEMENTS AND COSTS: (1962-63) Continued construction of basic facility, Cost \$2,517,000; (1964-65) Continued construction of basic facility, Cost \$494,000; (1966-67) Continued construction and removal of 14-inch tunnel, Cost \$325,000; (1968-69) Removal of 14-inch tunnel and LPG Plant, Cost \$56,000.	

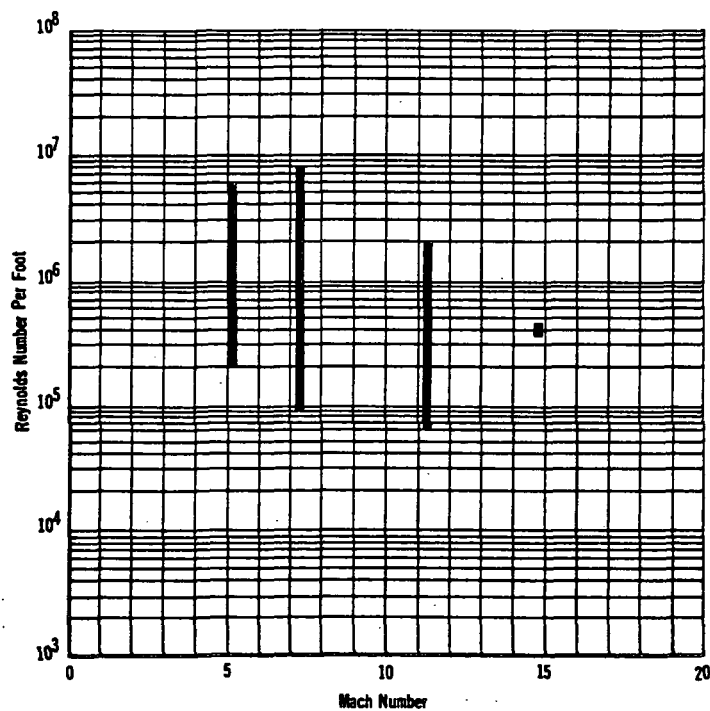
Note: Some costs include the NASA Ames 30-Inch Electric Arc Shock Tunnel.

PLANS FOR FACILITY IMPROVEMENTS:

*Electric power and data reduction costs which vary widely from test to test are not included.



FACILITY PERFORMANCE DATA



Mach Range: 5, 7, 10, 14
 Reynolds Number ($\times 10^6/\text{ft}$): .06 to 8
 Total Pressure (psia): 44.1 to 1985
 Dynamic Pressure (psf): 332 to 2550
 Total Temperature ($^{\circ}\text{R}$): 3460
 Run Time (seconds): 15 to 240

NASA AMES 20-INCH HYPERSONIC HELIUM TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Moffett Field, California 94035	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Hypersonic Aerodynamics Branch
OTHER SOURCES OF INFORMATION: Report No. NASA TMX-660; TMX-854; TMX-1032	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mail Stop N-229-1 Phone: (415) 961-1111

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is an intermittent blowdown to vacuum type wind tunnel. The test section is 20-inches in diameter with a 10 to 14-inch diameter test core. The test medium is helium. This facility is equipped with contoured nozzles.

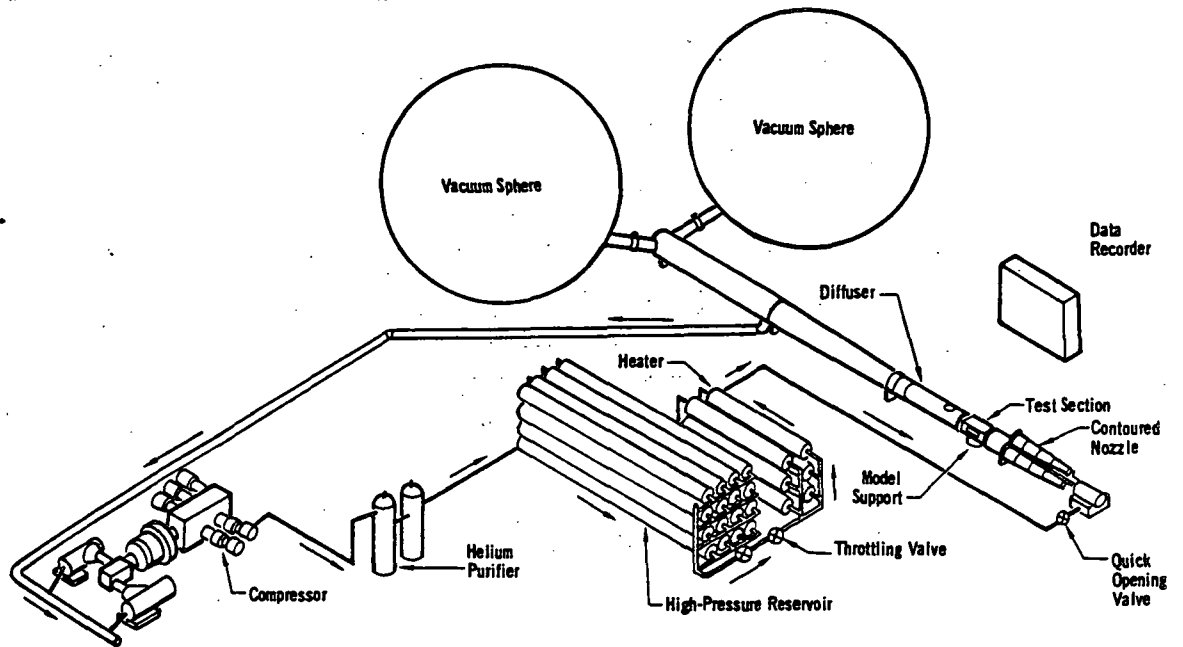
TESTING CAPABILITIES: Research in the fields of heat, mass, and momentum transfer, and spacecraft aerothermodynamics is conducted in this tunnel. Models are sting mounted. In addition, a launcher for free-flying model tests is also available. The tunnel is instrumented for research purposes. Data are recorded on a Beckman 210, (100:400 channels with switching), and reduced on site with digital computers. This facility is capable of four runs per day.

FACILITY COST HISTORY

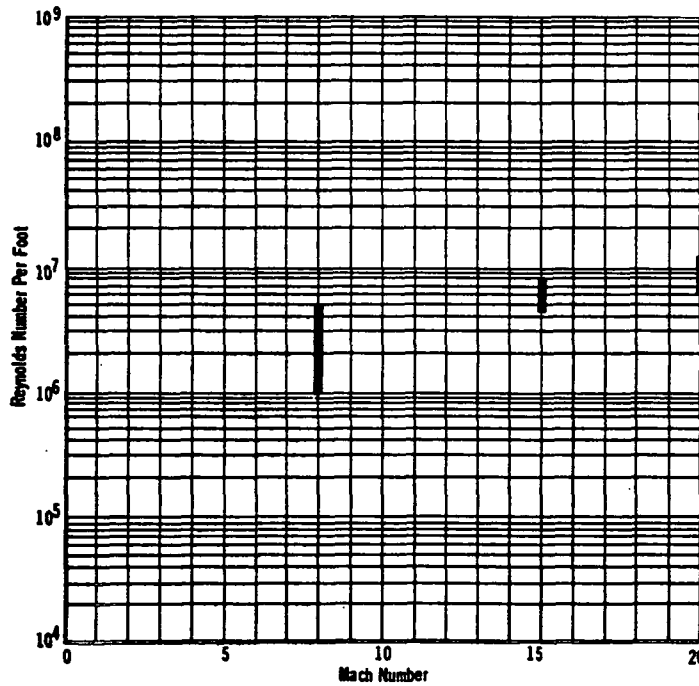
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1961 COST \$1,778,000 ESTIMATED REPLACEMENT VALUE \$3,819,000
CONTRACTOR: Western Gear Inc.; Chicago Bridge & Iron Co. LOCATION: IMPROVEMENTS AND COSTS: (1962-63) Continued construction of basic facility, Cost \$862,000; (1964-65) Retractable shoes for heat transfer studies, Cost \$34,000; (1966-67) Design and modification for radiation lab., Cost \$86,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	8, 15, 20, 26
Reynolds Number ($\times 10^6/\text{ft}$):	1 to 13
Total Pressure (psia):	353 to 4200
Dynamic Pressure (psf):	260 to 1960
Total Temperature ($^{\circ}\text{R}$):	610
Run Time (seconds)	40 to 120

NASA AMES HYPERVELOCITY FREE-FLIGHT FACILITY

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-237-1 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Vehicle Environment Division, Hypersonic Free-Flight Branch
OTHER SOURCES OF INFORMATION: "Ames Research Facilities Summary" Vol. I "Guns and Ranges" December 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Hypersonic Free-Flight Branch Building N-237 Phone: (415) 96-1111, ext 2376

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The Hypervelocity Free-Flight Facility is used for research on gasdynamic problems of hypervelocity flight, particularly problems of atmosphere entry. High relative speeds are achieved by launching models (in sabots if necessary) from high-speed guns generally into countercurrent hypersonic airstreams driven by combustion-powered shock tubes. Parameters derived from observations of the model flights include: lift, drag, static and dynamic stability, flow characteristics including absolute spectral emissive power of shock layers, wakes, and model ablation. This facility includes three gun-range combinations:

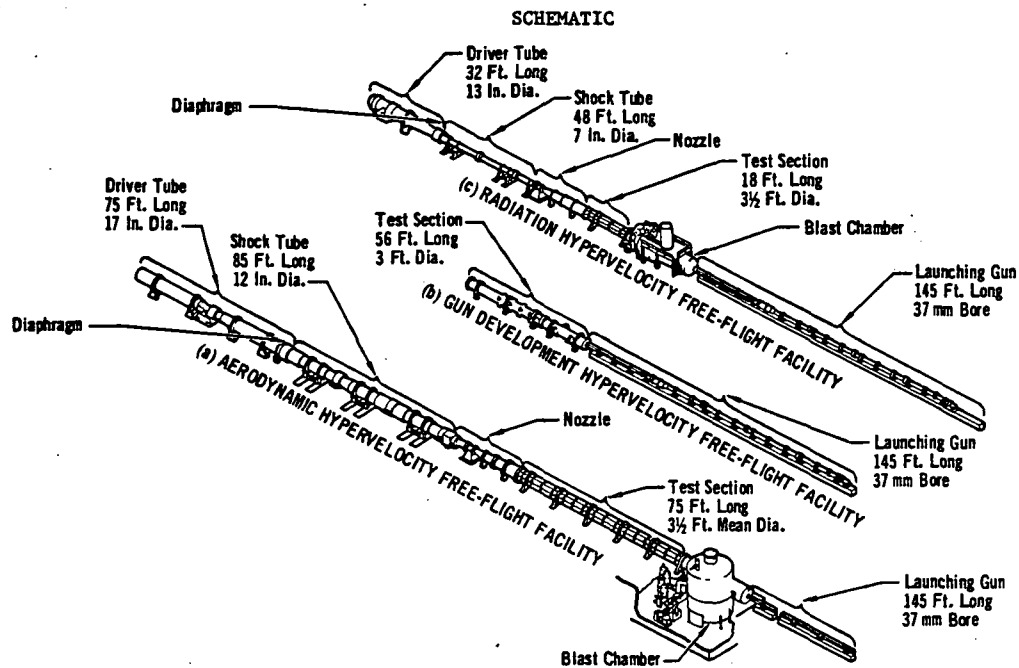
- Aerodynamic Hypervelocity Free-Flight Facility (3.5-foot test section)
- Gun-Development Hypervelocity Free-Flight Facility (3-foot test section)
- Radiation Hypervelocity Free-Flight Facility (3.5-foot test section)

TESTING CAPABILITIES: The three facilities share a variety of model-launching guns. The Aerodynamic Facility has the longest test section and greatest number of observing stations as these are necessary for accurately assessing gasdynamic forces and moments. Its shock tube produces a test stream of the relatively long duration required for the test period. The Radiation Facility has a shorter test section with fewer observing stations and is used for measuring radiation from the disturbed gases. Its shock tube gives a test stream of shorter duration. The purpose of the Gun-Development Facility is indicated by its name. In contrast to the other two facilities, it does not have a shock tube or countercurrent gas stream. It has a short test section for observing gun and model performance, sabot separation, etc.

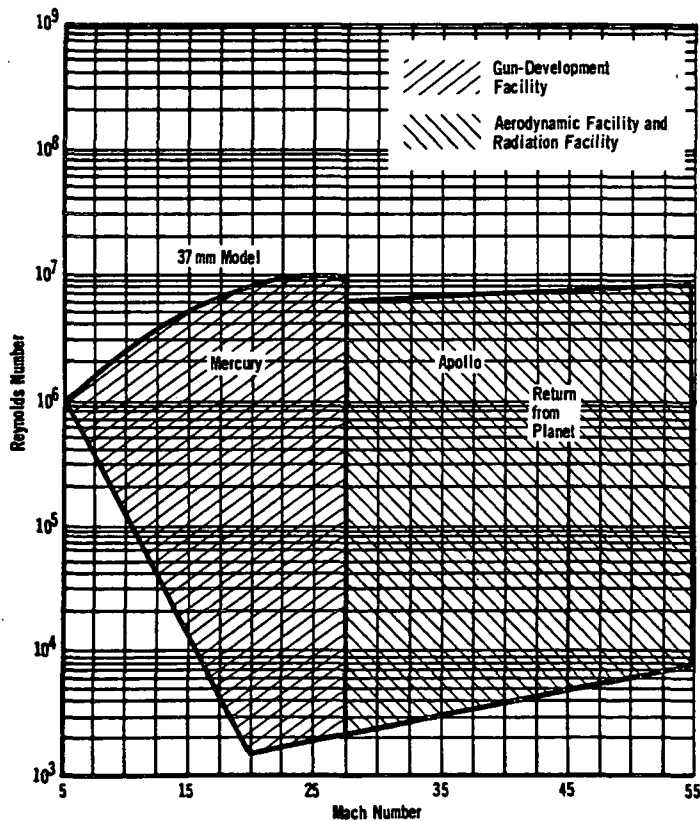
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1964 COST \$4,206,000 ESTIMATED REPLACEMENT VALUE \$7,081,000
CONTRACTOR: Carl N. Swenson	LOCATION: San Jose, California
IMPROVEMENTS AND COSTS: (1965) Continued construction of basic facility, Cost \$1,024,000; (1966) Continued construction of basic facility, Cost \$245,000; (1969) Additional construction, Cost \$3000.	

PLANS FOR FACILITY IMPROVEMENTS: None



FACILITY PERFORMANCE DATA



	Aero	Gun	Radiation
Static Pressure (atm):	.005 to .2	.001 to .2	.005 to .2
Reynolds Number ($\times 10^6$):	80	80	80
Model Speed ($\times 10^3$ ft/sec):	30	30	30
Gas Speed ($\times 10^3$ ft/sec):	16	0	16
Model Diameter (millimeters):	37	37	37
Model Weight (grams):	45	45	45

NASA AMES PROTOTYPE HYPERVELOCITY FREE FLIGHT FACILITY

REPORTING INSTALLATION: NASA Ames Research Center Mail Stop N-237-1 Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Vehicle Environment Division, Hypersonic Free Flight Branch
OTHER SOURCES OF INFORMATION: "Ames Research Facilities Summary" Vol. I "Guns and Ranges", December 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Hypersonic Free Flight Branch Building N-237 Phone: (415) 961-1111, ext 2376

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility consists of a 40 foot driver tube, 40 foot shock tube, nozzle, two foot diameter test section, blast chamber and 12mm launching gun. High relative speeds are achieved by launching models (in sabots, if necessary) from high speed gun into a countercurrent hypersonic air-stream which is driven by a combustion powered shock tube. The test section is 40 foot long and its largest high-performance gun has a 12mm bore. These factors limit the precision of aerodynamic data and the range of test Reynolds number achievable.

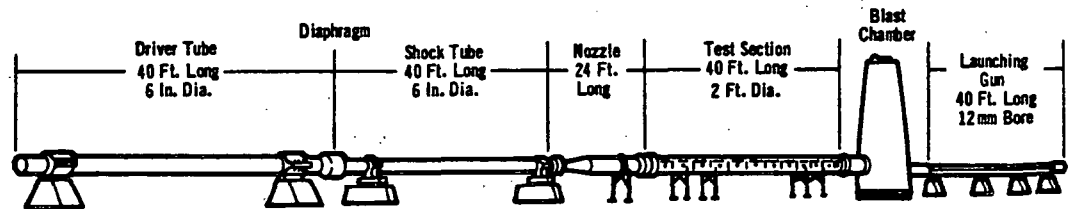
TESTING CAPABILITIES: This facility can handle models up to 12 millimeters in diameter with a weight of 3 grams. Flow visualization consists of shadowgraph with eleven stations for viewing.

FACILITY COST HISTORY

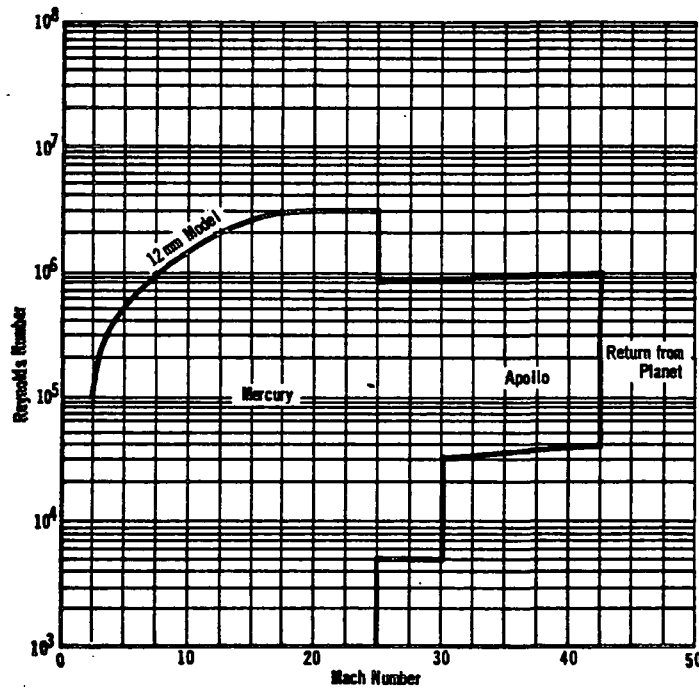
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1962 COST \$ 374,000 ESTIMATED REPLACEMENT VALUE \$1,104,000
CONTRACTOR: Carl N. Swenson	LOCATION: San Jose, California
IMPROVEMENTS AND COSTS: (1963-64) Communications and other modifications, Cost \$10,000; (1965-67) Design and construction of Prototype HFF Facility, Cost \$474,000.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHMATIC



FACILITY PERFORMANCE DATA



Static Pressure (atm):	.0013 to .07
Reynolds Number ($\times 10^6$):	to 80
Model Speed (ft/sec):	to 28,000
Gas Speed (ft/sec):	0 to 15,000
Model Diameter (millimeters):	12
Model Weight (grams):	3

NASA AMES 30-INCH ELECTRIC ARC SHOCK TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Fluids Mechanics Branch
OTHER SOURCES OF INFORMATION: Scientific Instru. Review V. 39 No. 11 pp. 1692-1696, Nov. 1968; NASA TN D-5126, April 1969	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mail Stop N-229-4 Phone: (415) 961-1111, ext 2575

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The facility uses an arc-heated helium driver, 10-feet in length, to develop a reflected-shock reservoir of test gas of the desired planetary gas mixture. The driver is energized by a 40-kV, one megajoule capacitor bank. A closed, hexagonal test section 2.5 by 2.5 by 3 feet joins to a 20° conical nozzle with a 30-inch exit diameter. The test core is 5 to 18 inches. The facility is also operated with a cold helium driver. The driver gas volume is .76 cu ft at 15,000 psia and the test gas volume is .03 to .13 cu ft at 1500 psia.

TESTING CAPABILITIES: Fixed models are used for pressure, heat transfer, shock interaction, and surface flow direction tests. Force measurements can be made in the available test time using accelerometers. High-speed motion pictures are used to define model shock envelopes. Data are recorded on a 500,000 sample per second digital recorder and reduced off site with a 7040/7094 digital computing system. This facility is capable of one shot per day.

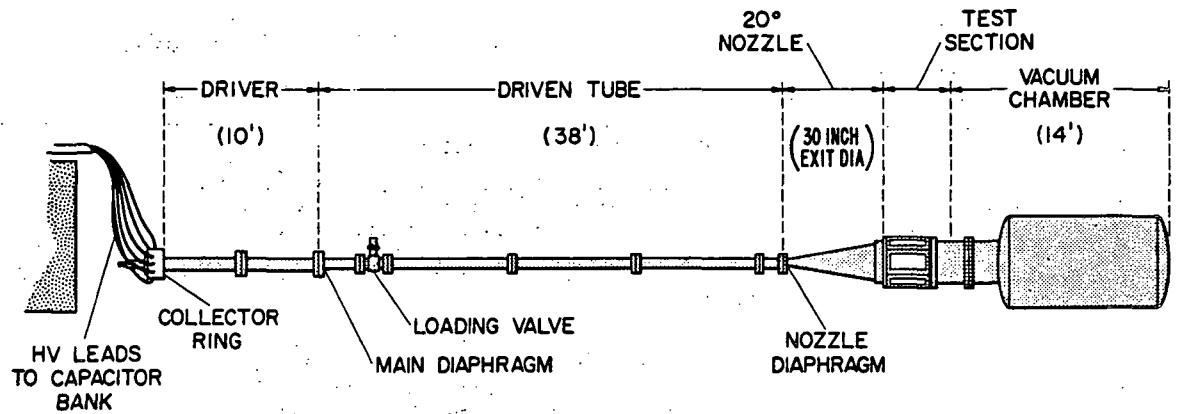
FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1965	COST \$
CONTRACTOR: General Electric	ESTIMATED REPLACEMENT VALUE \$	
IMPROVEMENTS AND COSTS:	LOCATION:	

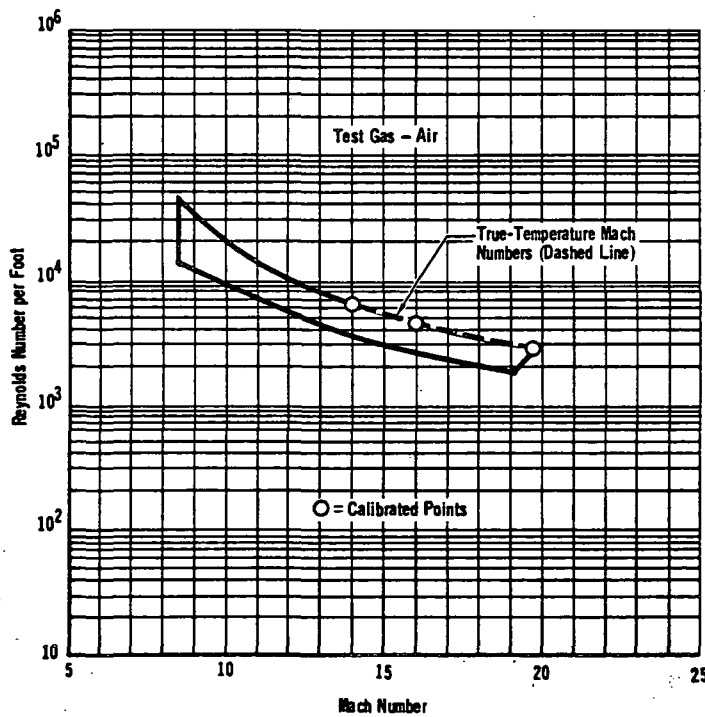
Note: The cost history is shared with and combined in the cost data on the NASA Ames 3.5-Foot Hyper-sonic Wind Tunnel.

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	8.5 to 19.7
Reynolds Number (x 10 ⁶ /ft):	.002 to .045
Total Pressure (psia):	500 to 1500
Dynamic Pressure (psf):	6 to 210
Total Temperature (°R):	10,000 to 16,500
Run Time (seconds):	.0015

NASA AMES ENTRY-AERODYNAMICS TUNNEL AND HEAT-TRANSFER TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Thermal Protection Branch
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mail Stop N-234-1 Phone: (415) 961-1111, ext 2531

DESCRIPTION AND TESTING CAPABILITIES

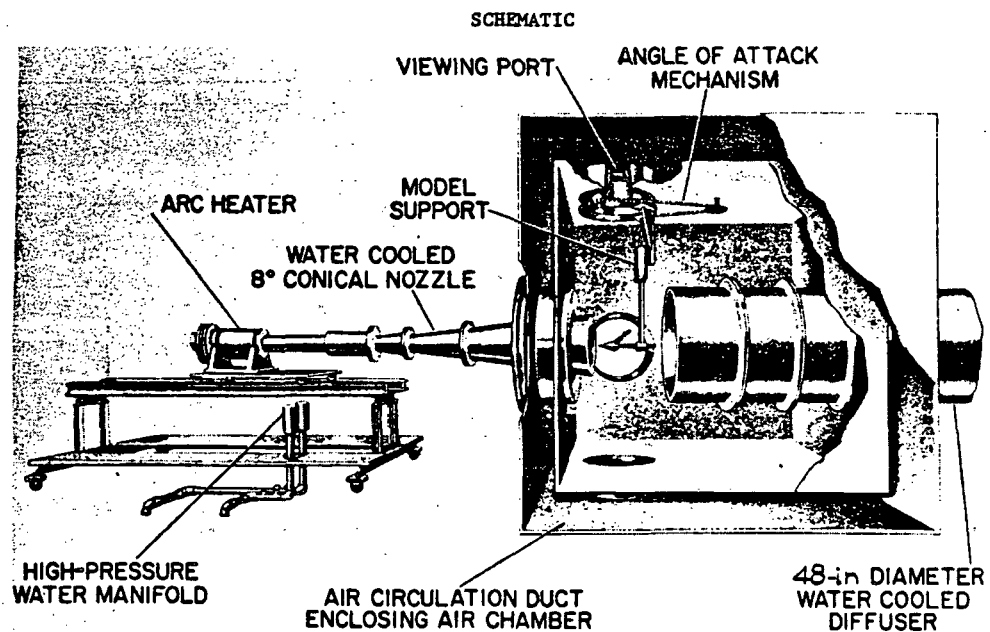
FACILITY DESCRIPTION: This facility consists of two arc heated hypersonic wind tunnel legs powered by a 20-megawatt dc supply with a common vacuum system (5-stage steam ejector). The tunnel has an aerodynamic leg and a heat-transfer leg. The test medium is air, CO₂, N₂, and mixtures. Fixed nozzles having exit diameters of from 2- to 24-inches are used to provide the Mach number range of 2.5 to 14. Variations in Mach number for a given nozzle are obtained by changing the throat section. The Entry-Aerodynamics Tunnel and the Heat-Transfer Tunnel are identical except for model support systems.

TESTING CAPABILITIES: The tunnel's capabilities are material research in heat-shield applications and aerodynamic studies of vehicles in planetary atmosphere. Model sizes to 6 inches are used in this facility. Entry-Aerodynamics Tunnel has angle of attack and survey systems. Heat-Transfer Tunnel has a multiple model injection system which allows 18 models to be tested during a single run. Data are recorded on oscillograph (36 channels), and tape deck (14 channels) and reduced on site by computer, manual readings and cardpunch. These facilities are capable of 2 to 5 runs per day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1962 COST \$ 4,778,000 ESTIMATED REPLACEMENT VALUE \$12,602,000
CONTRACTOR: Carl N. Swenson; Southwestern Engineering Co. LOCATION: San Jose; Los Angeles, California IMPROVEMENTS AND COSTS: (1963-66) Continued construction of basic facility, Cost \$477,000; (1966-67) Continued construction including radiative heat system, Cost \$4,022,000; (1968-69) Radiative heat system, Cost \$602,000.	

PLANS FOR FACILITY IMPROVEMENTS: None



FACILITY PERFORMANCE DATA

Mach Range:	2.5 to 14
Reynolds Number ($\times 10^6/\text{ft}$):	.001 to 5
Total Pressure (psia):	15 to 1200
Dynamic Pressure (psf):	20 to 15,000
Total Temperature ($^{\circ}\text{R}$):	2500 to 15,000
Run Time (seconds):	400

NASA AMES MACH 50 HELIUM WIND TUNNEL

REPORTING INSTALLATION: NASA Ames Research Center Moffett Field, California 94035	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Hypersonic Aerodynamics Branch
OTHER SOURCES OF INFORMATION: NASA TN in preparation May 1970, "The Ames M-50 Helium Tunnel"	LOCAL OFFICE TO CONTACT FOR INFORMATION: Mail Stop N-229-1 Phone: (415) 961-1111, ext 2401

DESCRIPTION AND TESTING CAPABILITIES

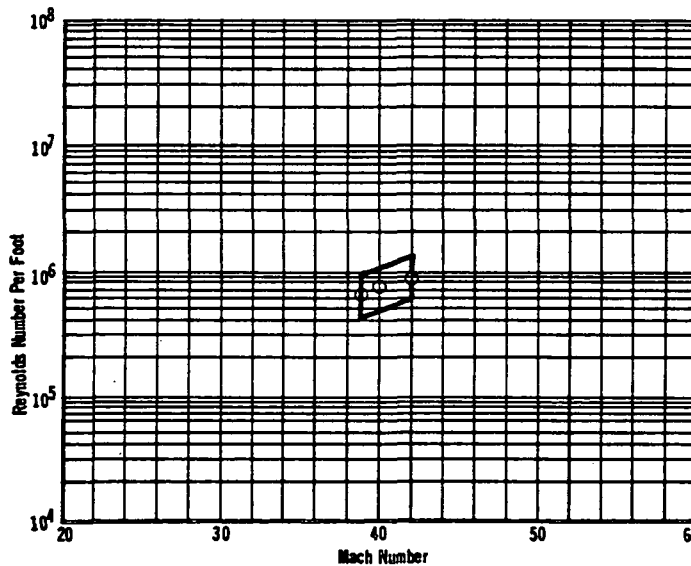
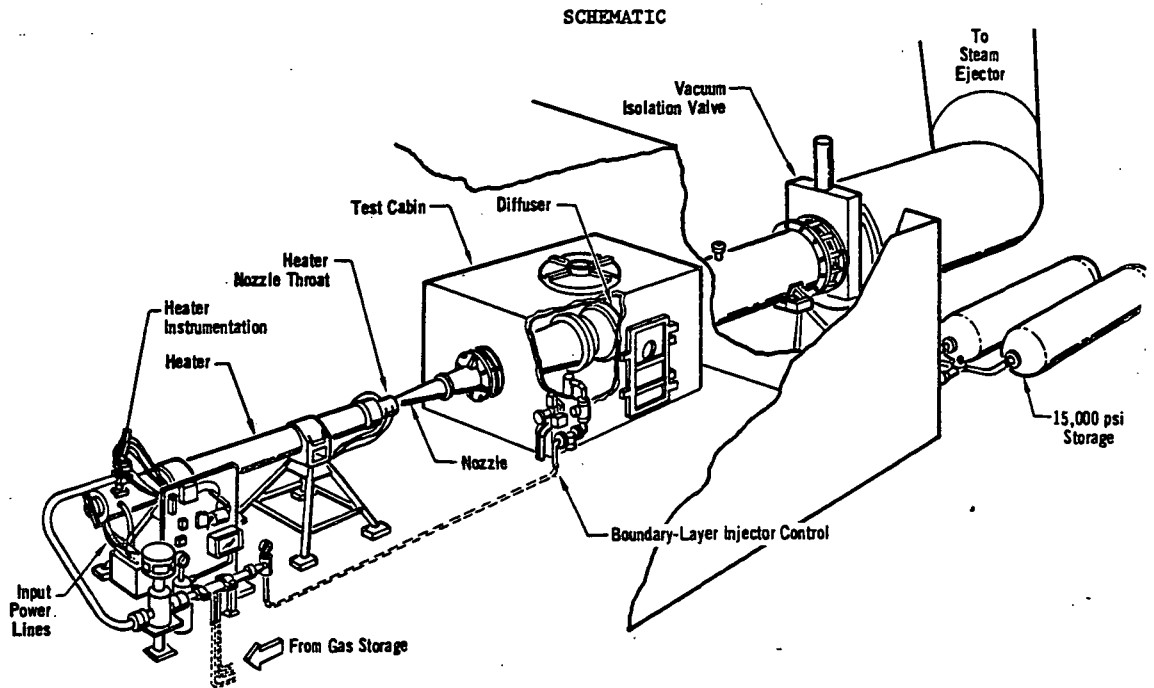
FACILITY DESCRIPTION: This facility is an intermittent blowdown to vacuum system type wind tunnel. The test section is 28-inches in diameter with an open jet and 4 inch diameter test core. The tunnel is equipped with an electric resistance heater. The test medium is helium.

TESTING CAPABILITIES: Tests conducted include force, moment, pressure, and heat transfer studies. The combination of high Mach number and low densities produce very thick boundary layers making the tunnel very useful for boundary-layer and boundary-layer interaction studies. Models are mounted on a variable angle sting with injection capabilities. Data are recorded with, (100 channels), Beckman 210 and reduced on site with digital computers. This facility is capable of three runs per day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1964 COST \$1,530,000 ESTIMATED REPLACEMENT VALUE \$2,259,000
CONTRACTOR: Allied Engineering, Inc.	LOCATION: Alameda, California
IMPROVEMENTS AND COSTS: (1965-66) Adjustment, Cost \$87,000; (1967) Continued construction of basic facility, Cost \$205,000; (1968) Pumps, Cost \$8000; (1969) Test section, Cost \$117,000.	

PLANS FOR FACILITY IMPROVEMENTS: None



FACILITY PERFORMANCE DATA

Mach Range:	39 to 42
Reynolds Number ($\times 10^6/\text{ft}$):	.4 to 1.3
Total Pressure (psia):	1000 to 4000
Dynamic Pressure (psf)	Approx. 50
Total Temperature ($^{\circ}\text{R}$):	800 to 2000
Run Time (seconds):	1200

NASA JPL 43-INCH SHOCK TUNNEL

REPORTING INSTALLATION: NASA Jet Propulsion Laboratory 4800 Oak Grove Drive, Building 188 Pasadena, California 91103	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Aerothermodynamics Group, Aerophysics Section, Environmental Science Division
OTHER SOURCES OF INFORMATION: Performance of the JPL 43-inch Hypersonic Shock Tunnel, Technical Report 32-1370 March 1969	LOCAL OFFICE TO CONTACT FOR INFORMATION: Aerothermodynamics Group Phone: (213) 354-2173

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility consists of a 43-inch-diameter shock tunnel, a 34-ft long driven section, and a 9-ft long driver. The significant dimensions of the shock tube and the Hypersonic Shock Tunnel (HST) are shown in the schematic. A double-diaphragm technique is used for the shock tube so that the driver pressure can be adjusted to predetermined levels before firing. The diaphragms open into a 2.125-inch orifice section. Prior to charging, the driver is evacuated to a pressure of several microns with a mechanical pump. Before it is filled, the driven tube is evacuated to 2×10^{-4} millimeters of mercury by a diffusion pump. The Mach number variation at a Mach number of 12.5 is $\pm .2$. The 43-inch-diameter HST is separated from the driven tube by a brass diaphragm. Both a .750-inch-diameter and a 1-inch-diameter throat are available for the shock tunnel. The tunnel is evacuated to an intermediate pressure of about 250 μ Hg by a Stokes 80-ft/min Microvac pump and then to a few microns of mercury by a diffusion pump. This facility has an eight inch diameter test core. The test gas (N_2) has a volume of 2 cu ft with a maximum pressure of .2 psia. The driver gas (H_2) has a volume of .5 cu ft with a maximum pressure of 1800 psia.

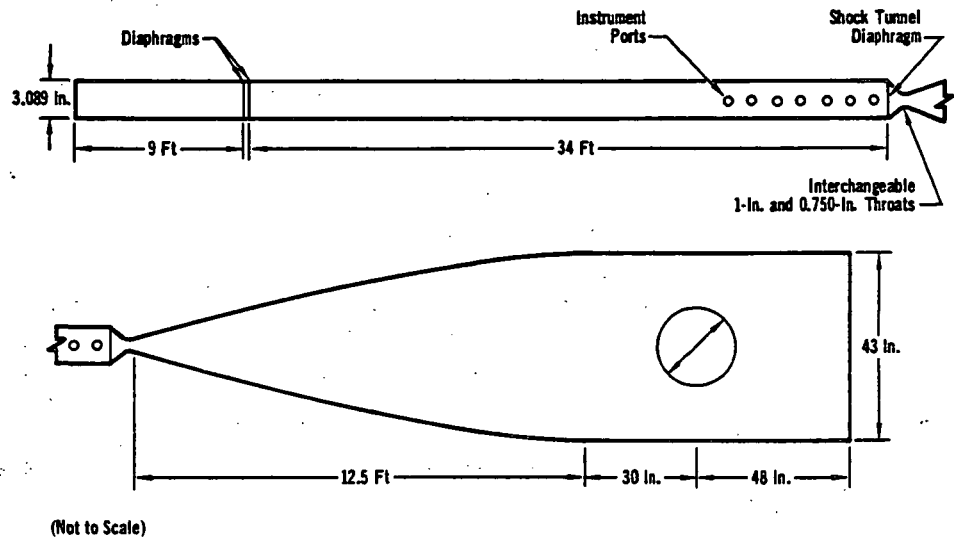
TESTING CAPABILITIES: This tunnel has been used for pressure and heat transfer distribution measurements on blunt planetary entry probe models. Pressure is measured with a specially mounted crystal transducer and surface temperature is measured with a platinum thin film gage. Models are sting mounted. Data are recorded with an oscilloscope (7 channels) and reduced manually with computer processing.

FACILITY COST HISTORY

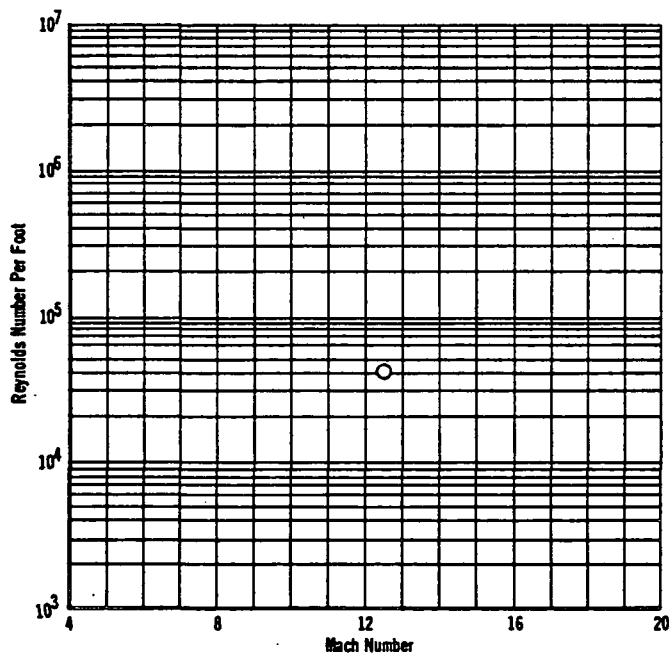
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$200	CONSTRUCTION YEAR: 1965 COST \$ ESTIMATED REPLACEMENT VALUE \$100,000
CONTRACTOR: Jet Propulsion Laboratory IMPROVEMENTS AND COSTS: Not Available	LOCATION: Pasadena, California

PLANS FOR FACILITY IMPROVEMENTS: (1) Improved dump tank, (2) quick release mechanism for windows, (3) increased driver pressure capability, and (4) improved model support.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 12.5

Reynolds Number ($\times 10^6/\text{ft}$): .042

Total Pressure (psia): 500

Dynamic Pressure (psf): 70

Total Temperature ($^{\circ}\text{R}$): 6080

Run Time (milliseconds): .7

NASA JPL 21-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: NASA Jet Propulsion Laboratory 4800 Oak Grove Drive, Building 80 Pasadena, California 91103	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aerophysics Section, Environmental Sciences Division
OTHER SOURCES OF INFORMATION: Jet Propulsion Laboratory, Wind Tunnel Facilities; Report JPL TECH. Memo 33-335	LOCAL OFFICE TO CONTACT FOR INFORMATION: Experimental Systems Group Phone: (213) 354-2781

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is a closed circuit, single return, continuous flow, variable density type hypersonic tunnel. The test section is 25 in. high by 20 in. wide by 70 in. long with a nominal test core of 12 by 12 inches. A two-dimensional flexible nozzle can provide infinite choice of test section Mach numbers within a specified range. In the Mach number range from 4 to 11, the test section Mach number variation is ± 0.04 . A refrigeration dryer is used to extract as much as 90% of the moisture from the air; activated alumina beds extract much of the remaining moisture. The tunnel is equipped with an electric heater, which can vary the supply air temperature from 100° to 1350°F. This facility is powered by four compressors capable of 11,000 hp output.

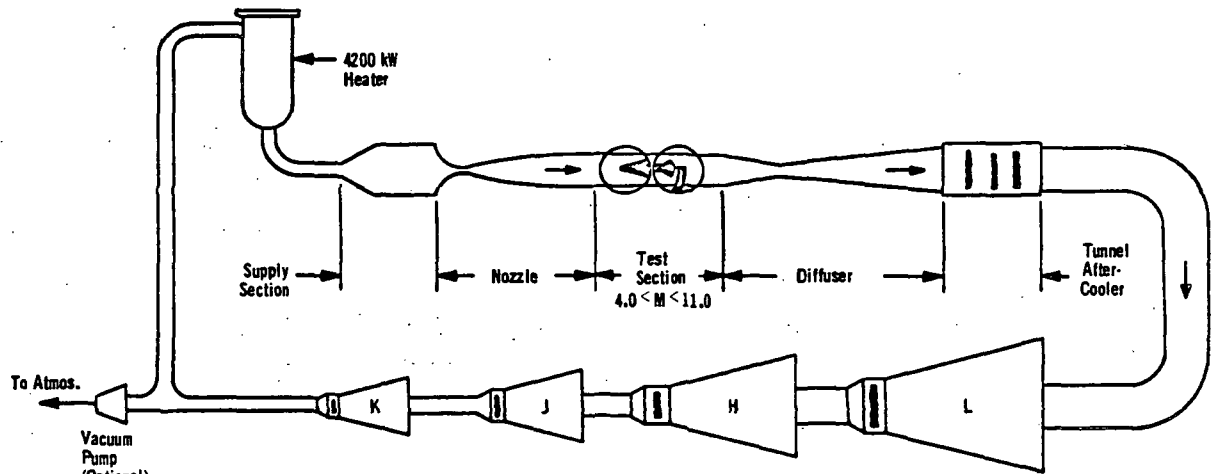
TESTING CAPABILITIES: Force and moment, pressure, heat transfer, dynamic stability, free flight, multi-gas tests, and low Reynolds number studies have been performed in this tunnel. Models may be sting or strut mounted, wire-supported and released, or pneumatically launched into free flight. For sting mounted models, angle of attack range varies from -10° to +20°, angle of roll from 0° to 360°. The nozzle consists of a two-dimensional, variable contour. The Mach number can be varied from 4 to 11 and an earth pressure altitude from 85,000 to 220,000 ft. Testing has been performed using various gases such as carbon dioxide-air mixtures. Flow visualization is obtained by schlieren, shadowgraph, oil flow movies, and ionization probe techniques. Data recording and reduction are performed with a PDP-1 computer (on site) capable of measuring a total of 176 channels.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$2300*	CONSTRUCTION YEAR: 1959 COST \$
CONTRACTOR: Jet Propulsion Laboratory	ESTIMATED REPLACEMENT VALUE \$15,000,000
IMPROVEMENTS AND COSTS:	LOCATION: Pasadena, California
<p>* Represents the cost of a research type test without the data system. † Represents the cost of a production type test including data system.</p>	

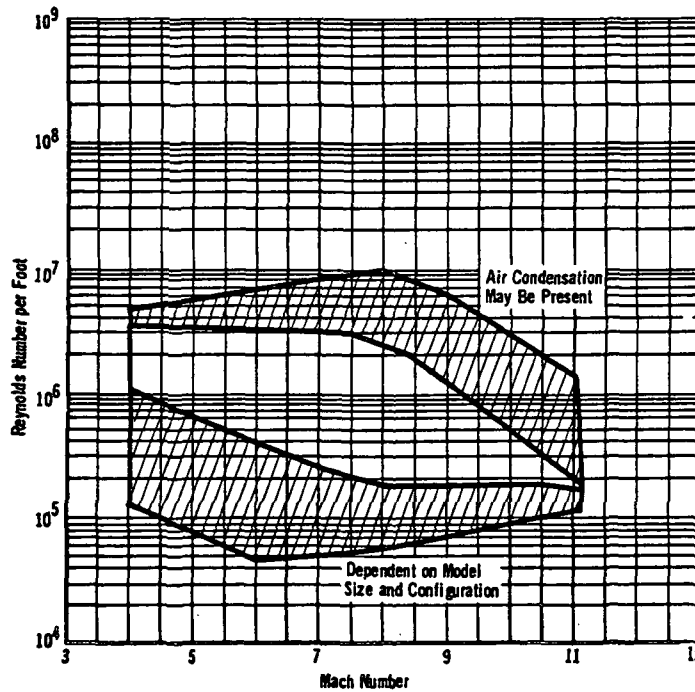
PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



Compressor Unit	Inlet Capacity (cfm)	Compression Ratio	Design Maximum Pressure (psia)	Motor (hp)
L	82,000	3.8:1	18	4,000
H	22,000	10.0:1	85	3,000
J	3,500	3.4:1	275	2,000
K	1,075	2.7:1	715	2,000

FACILITY PERFORMANCE DATA



Mach Range:	4 to 11.3
Reynolds Number ($\times 10^6/\text{ft}$):	.048 to 9.6
Total Pressure (psia):	4 to 700
Dynamic Pressure (psfa):	12.96 to 460
Total Temperature ($^{\circ}\text{R}$):	560 to 1810
Run Time:	Continuous

NASA LANGLEY 8-FOOT HIGH TEMPERATURE STRUCTURES TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Structures Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Structures Research Division
OTHER SOURCES OF INFORMATION: NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to atmosphere type facility. This facility achieves the required energy level for flight simulation by burning methane in air under pressure and using the resulting combustion products as the test medium. The test section diameter is 96 inches. The nozzle is a conical-contoured axisymmetric design with an exit diameter of 8 ft.

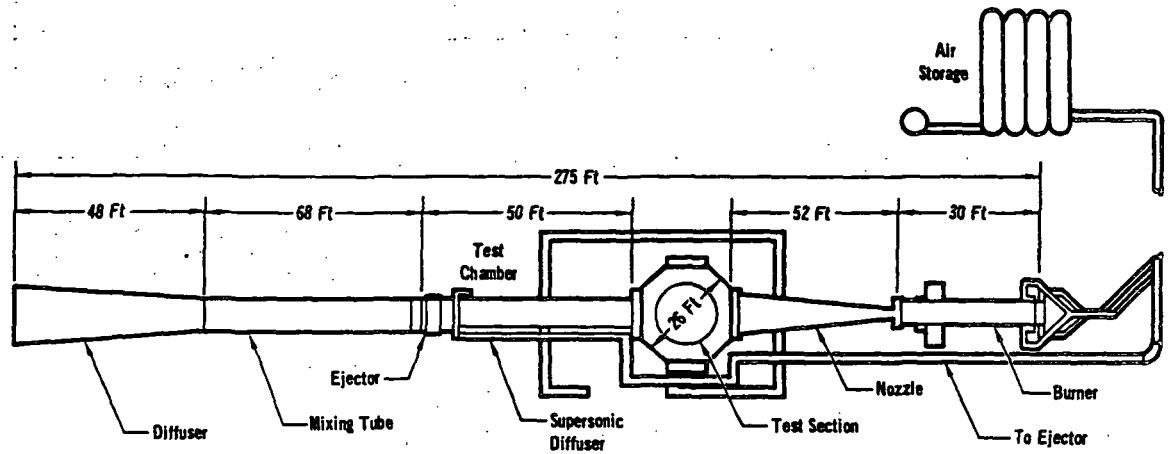
TESTING CAPABILITIES: The tunnel is used for studying structures and thermal protection for hypersonic flight. Model mounting is semispan or sting with insertion after tunnel is started. A 1/12th scale pilot facility of the 8-Foot High Temperature Structures Tunnel having the same basic modes of operation exists and is used for R&D purposes. The maximum stagnation pressure for the pilot tunnel is limited to 2100 psia. The Langley Central Data Reduction Center and tie-ins are available.

FACILITY COST HISTORY

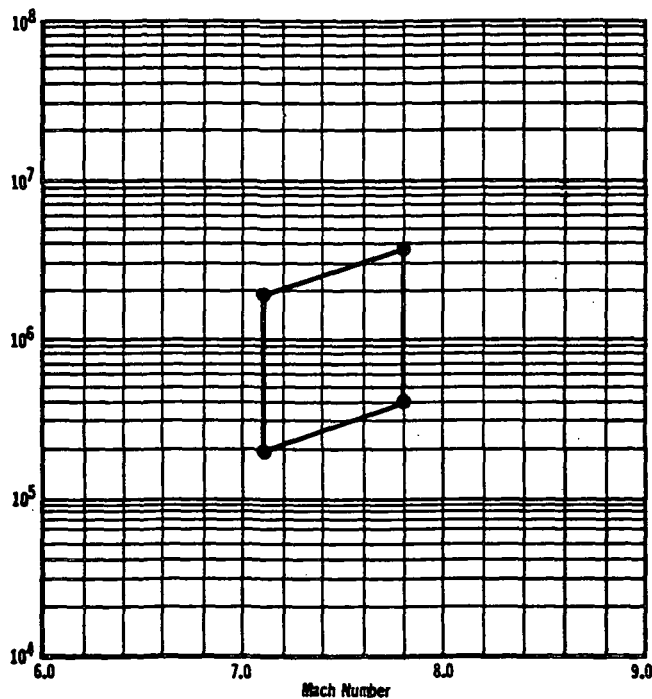
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT).	CONSTRUCTION YEAR: 1964 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	7.1 to 7.8
Reynolds Number ($\times 10^6/\text{ft}$):	.20 to 3.75
Total Pressure (psia):	400 to 4,000
Dynamic Pressure (psf):	216 to 2190
Total Temperature ($^{\circ}\text{R}$):	2500 - 4000
Run Time (seconds):	0 to 140

NASA LANGLEY HIGH REYNOLDS NUMBER HELIUM TUNNELS

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: In Calibration COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics Division
OTHER SOURCES OF INFORMATION: NASA TMX-1130, July 1965	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is an intermittent blowdown to vacuum facility. The test medium is helium. Two separate test legs are installed, both using axisymmetric, contoured nozzles. The test section diameter of Mach number 10 leg is 37 inches with 30-inch usable test core. Test section diameter of Mach number 20 leg is 60 inches with 34-inch usable test core. This facility is equipped with helium storage, purification, and pumping system. The tunnel has no heater.

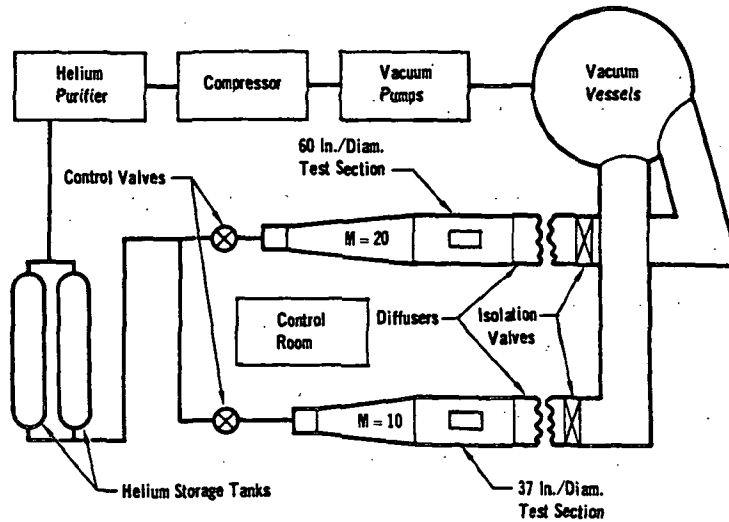
TESTING CAPABILITIES: Aerodynamic, aeroelastic and fluid mechanic problems may be investigated at hypersonic speeds, with emphasis upon turbulent flow effects. Model mounting consists of variable angle sting and strut type supports. Data are recorded with 100 channels on a Beckman recorder and reduced off-site with a CDC 6600 computer system. This facility is capable of 2 runs per day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1967 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

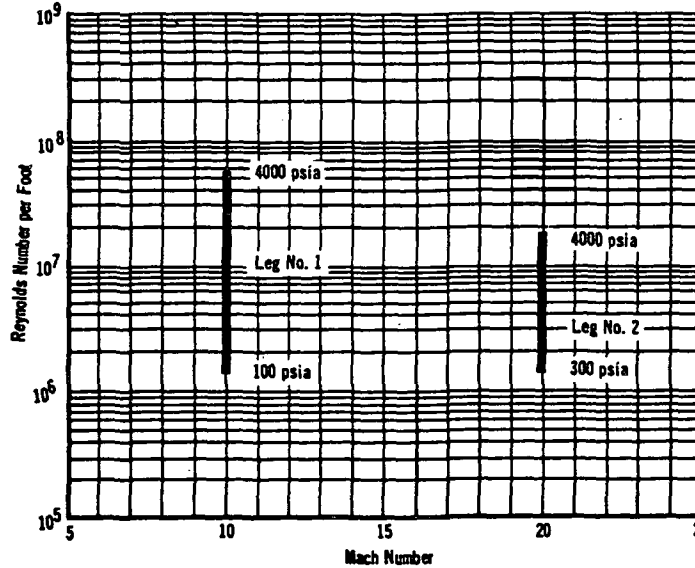
PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

M = 10 LEG NO. 1



Mach Range:	10
Reynolds Number ($\times 10^6/\text{ft}$):	1.43 to 57
Total Pressure (psia):	100 to 4000
Dynamic Pressure (psf):	200 to 6900
Total Temperature ($^{\circ}\text{R}$):	540
Run Time (seconds):	10

M = 20 LEG NO. 2

Mach Range:	20
Reynolds Number ($\times 10^6/\text{ft}$):	1.3 to 18
Total Pressure (psia):	300 to 4000
Dynamic Pressure (psf):	69 to 920
Total Temperature ($^{\circ}\text{R}$):	540
Run Time (seconds):	20

NASA LANGLEY 4-FOOT HYPERSONIC ARC TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics Division
OTHER SOURCES OF INFORMATION: "Review of Testing Techniques and Flow Calibration Results For Hypersonic Arc Tunnels", AIAA Paper No. 68-379, April 1968	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is an arc fired type facility. The test section diameters are 24 and 48 inches. Test-core sizes of the 24-inch test section ranges from 12 inches to 18 inches, depending on operating stagnation conditions. The nozzle is conical. The tunnel exhausts into a 100-foot vacuum sphere. The test medium is usually air heated by an electric arc with a 10 to 30 megawatt dc power supply.

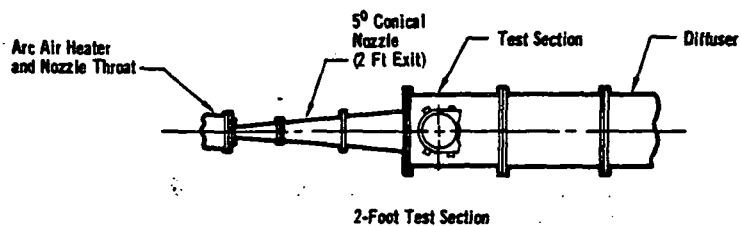
TESTING CAPABILITIES: This facility is capable of force, pressure, heat transfer, and flow kinetic studies at moderate enthalpies and low densities. Model mounting consists of a model plunging apparatus: side wall mounting with fixed strut; and an angle-of-attack sector. Data are recorded with 45 channels. This facility is capable of one to two runs per day.

FACILITY COST HISTORY

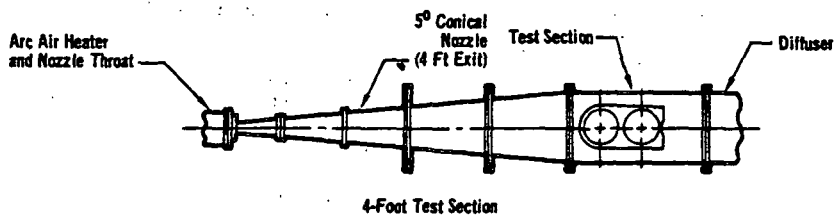
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1964 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	

PLANS FOR FACILITY IMPROVEMENTS: None

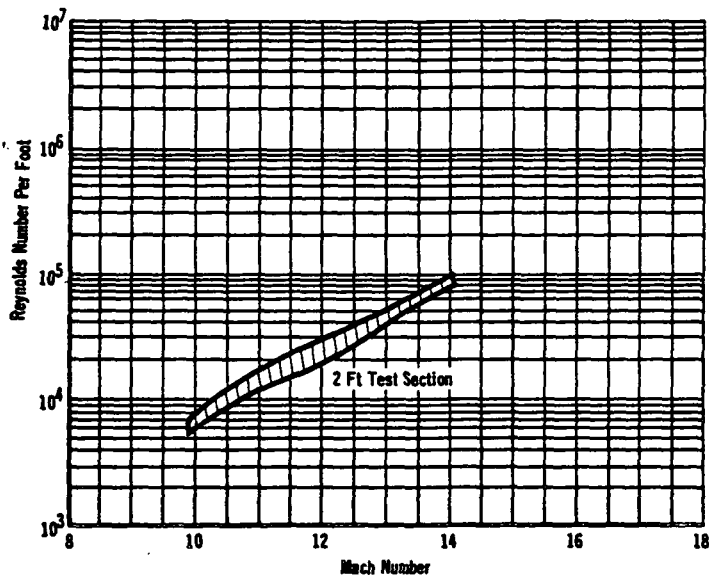
SCHEMATIC



Note: A 4" dia. exit nozzle has been used for research at $M = 7$
and $Re = 0.4 \times 10^6 / Ft$



FACILITY PERFORMANCE DATA



Mach Range:	8 to 18
Reynolds Number ($\times 10^6 / ft$):	.01 to .1
Total Pressure (psia):	250 to 1700
Dynamic Pressure (psf):	13 to 40
Total Temperature ($^{\circ}R$):	To 10,000
Run Time (seconds):	45

NASA LANGLEY CONTINUOUS-FLOW HYPERSONIC TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Space Systems Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Space Systems Research Division
OTHER SOURCES OF INFORMATION: NASA Technical Note D-2302, October 1964 NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel may be operated either as a continuous flow type tunnel at Mach 10, (at a future date Mach 11), or as an intermittent flow type at Mach 12. The Mach 12 nozzle has only been run blowdown for a maximum of 20 seconds. The tunnel is equipped with a vacuum tank for starting. The test medium is air heated by an electrical resistance heater. The test section is 31 by 31 by 72 inches with a 10 to 20 inch test core. Stagnation pressure is variable to a maximum of 150 atmospheres at Mach 10 and 300 atmospheres at higher speeds. Temperature is varied to avoid condensation of the air stream. Low pressure starting (exhausting to a vacuum sphere) reduces starting loads. Operating in a closed circuit, the facility is capable of unlimited test time. This facility is powered by a 24,000 hp main drive.

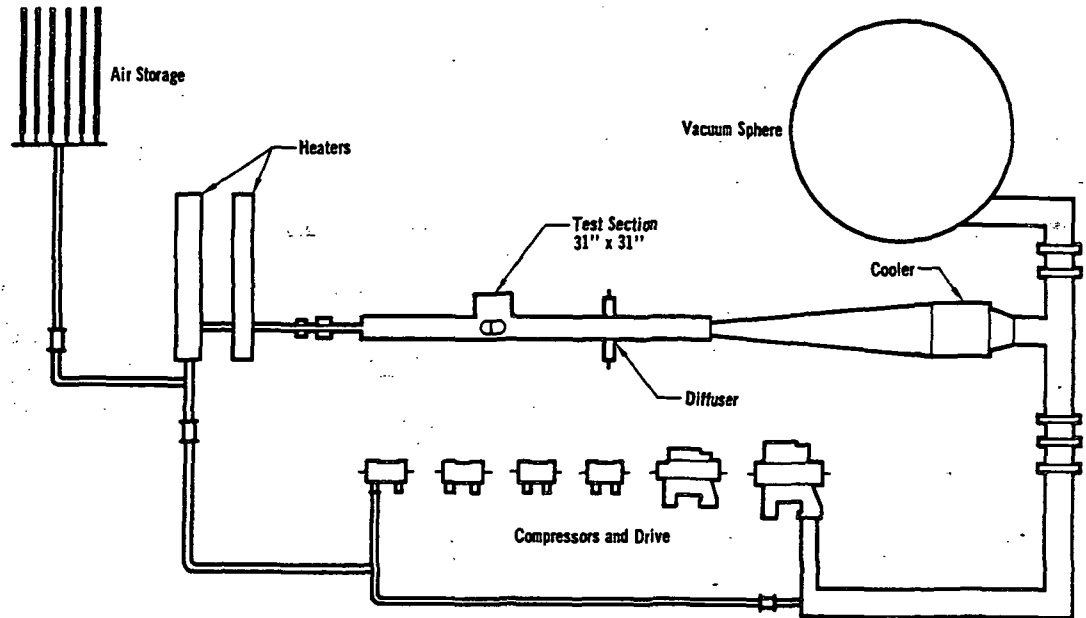
TESTING CAPABILITIES: This facility is capable of hypersonic aerodynamics and heat transfer type tests. Model mounting allows for variable angles of attack and yaw on models up to 17 inches in span and 5 feet in length. Standard instrumentation provides 6-component force measurement on cooled, strain gage balances; pressures and temperatures at up to 240 stations can be monitored and recorded at 10 times per second. Data are reduced off site with a CDC 6600 computer system.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1963 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: Mach 11 nozzle constructed, but not calibrated.

-SCHEMATIC



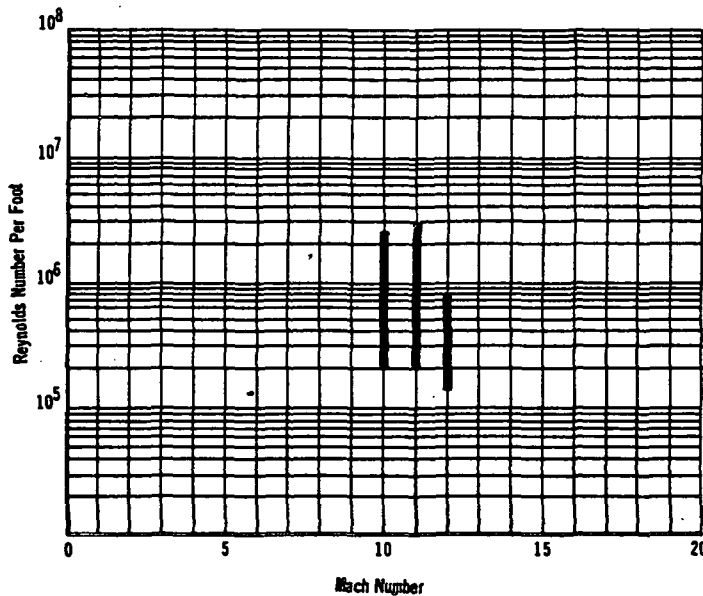
FACILITY PERFORMANCE DATA

Mach 10 Mode

Mach Range: .10
 Reynolds Number ($\times 10^6/\text{ft}$): .3 to 2.25
 Total Pressure (psia): 200 to 2100
 Dynamic Pressure (psf): 40 to 400
 Total Temperature ($^{\circ}\text{R}$): 1810 to 1960
 Run Time: Continuous

Mach 11 and 12 Modes

Mach Range: 11 and 12
 Reynolds Number ($\times 10^6/\text{ft}$): .3 to 30;
 .25 to .8
 Total Pressure (psia): 400 to 4500;
 400 to 1400
 Dynamic Pressure (psf): 50 to 550;
 35 to 125
 Total Temperature ($^{\circ}\text{R}$): 2260 to 2460 to
 2460 2660
 Run Time: Contin. 20 sec



NASA LANGLEY 22-INCH HELIUM TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Space Systems Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Space Systems Research Division
OTHER SOURCES OF INFORMATION: "NASA Technical Note, TND-2489, Sept. 1964"; NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to vacuum type facility. The test section is 22.5 inches in diameter and the test core is 8 inches to 10 inches in diameter. Three contoured nozzles supply discrete Mach numbers of 18, 22 and 24; however, only the Mach 22 nozzle has been calibrated. The test medium is purified helium. Test medium is supplied at ambient temperature or temperatures up to 400°F through electrical resistance heater. The helium exhausts into a vacuum tank.

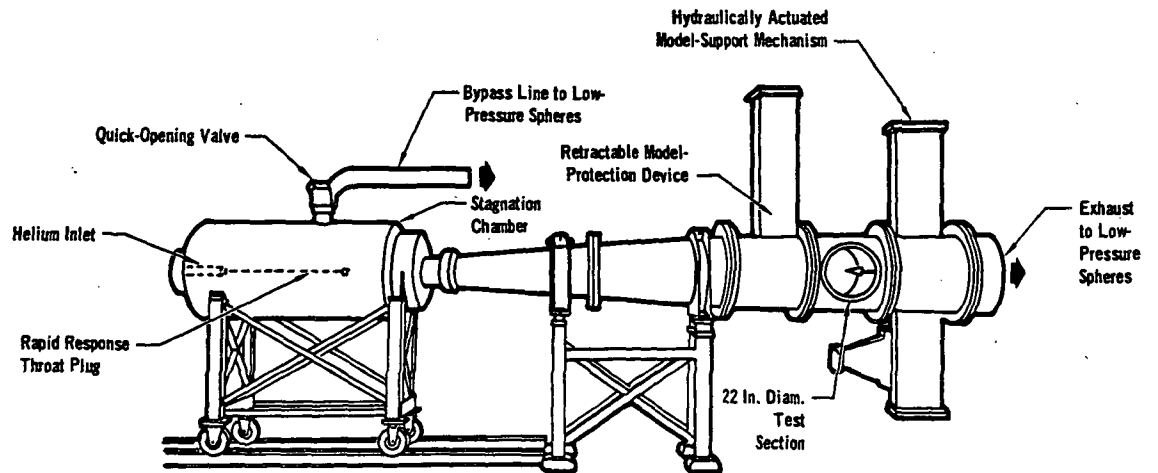
TESTING CAPABILITIES: This facility is used for force, pressure distributions, and heat transfer tests. Model mounting consists of a vertical strut. Flow visualization systems include schlieren, shadowgraph and electron beam. Data recorded with 99 channels on a Beckman recorder and reduced off site with a CDC 6600 computer system. This facility is capable of three runs per day.

FACILITY COST HISTORY

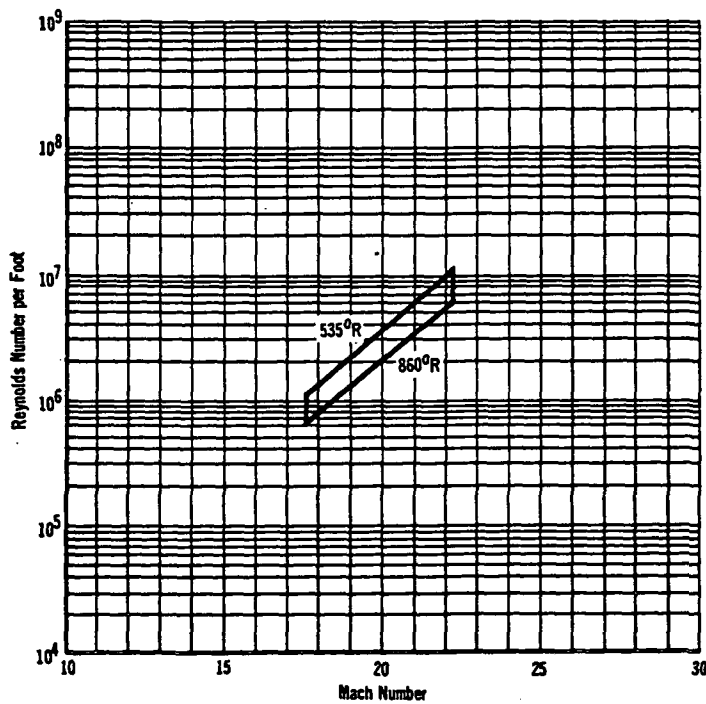
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1960 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: Mach-40 leg with open-jet test section (9' x 6' x 9') initial operation planned for first quarter fiscal year 1971.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	17.6 to 22.2
Reynolds Number ($\times 10^6/\text{ft}$):	.7 to 11.3
Total Pressure (psia):	200 to 3000
Dynamic Pressure (psf):	144 to 500
Total Temperature (°R):	535 to 866
Run Time (seconds):	40 to 60

NASA LANGLEY 20-INCH HYPERSONIC TUNNEL (MACH 8.5)

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics Division
OTHER SOURCES OF INFORMATION: NASA TMX-664, March 1962; NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a blowdown to atmosphere type facility. The test section is 21 inches in diameter, with a test core of 16 inches in diameter. The circuit exhausts through a movable second throat to atmosphere with aid of an annular ejector. The test medium is air and is heated by an electrical resistance heater. An axially symmetric contoured nozzle is used.

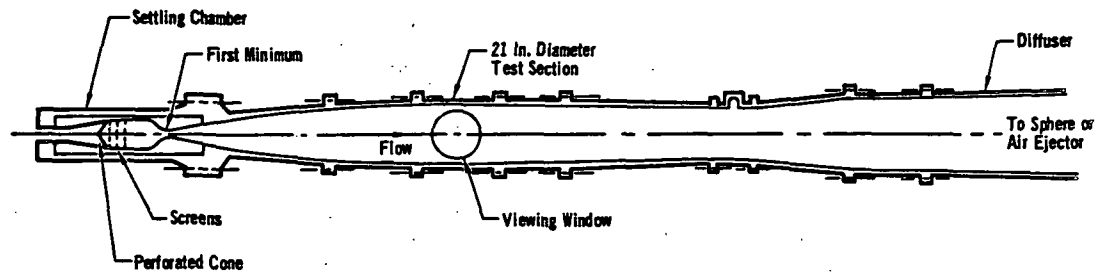
TESTING CAPABILITIES: This facility is capable of heat transfer, pressure and force type tests. Model mounting consists of a sting support and model injection mechanism. Data are reduced with a CDC 6600 computer system.

FACILITY COST HISTORY

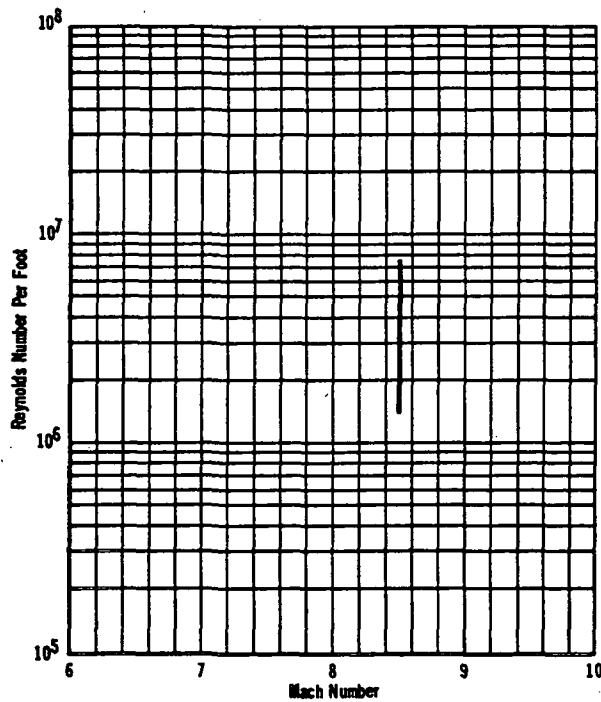
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1961 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	8.5
Reynolds Number ($\times 10^6/\text{ft}$):	1.5 to 7.5
Total Pressure (psia):	500 to 2500
Dynamic Pressure (psf):	250 to 1250
Total Temperature ($^{\circ}\text{R}$):	1500
Run Time (minutes):	1 to 7

NASA LANGLEY 20-INCH HYPERSONIC TUNNEL (MACH 6)

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics Division
OTHER SOURCES OF INFORMATION: NASA TND-1793, June 1963 NASA TND-618, December 1960 NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a blowdown to atmosphere type facility. The test section is 20 inches by 20 inches, with a test core of approximately 16 inches. The tunnel exhausts through a movable second throat into atmosphere with the aid of an annular ejector or into vacuum sphere. The test medium is air and is heated with an electrical resistance heater. The Mach 6 fixed nozzle blocks are two dimensional and contoured.

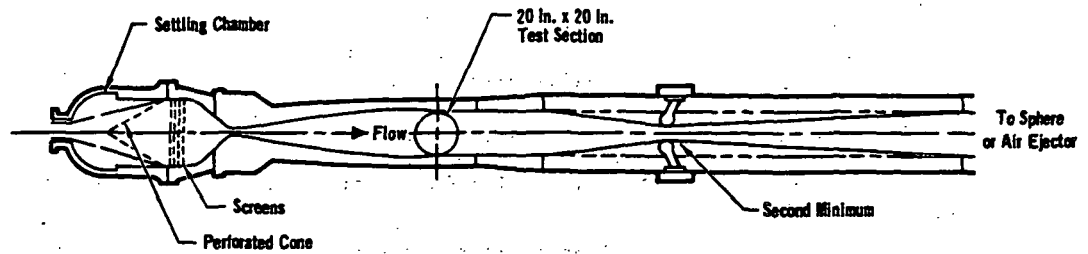
TESTING CAPABILITIES: This facility is capable of heat transfer, pressure and force testing. Model mounting consists of a sting support and model injection mechanism. Data are reduced off-site with a CDC 6600 computer system.

FACILITY COST HISTORY

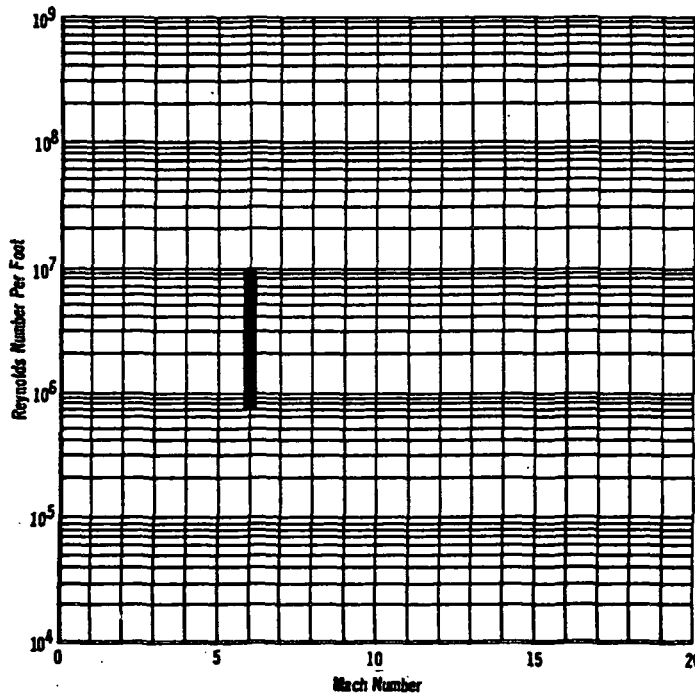
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1958 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	6
Reynolds Number ($\times 10^6/\text{ft}$):	.7 to 9.3
Total Pressure (psia):	50 to 525
Dynamic Pressure (psf):	115 to 1260
Total Temperature ($^{\circ}\text{R}$):	1000
Run Time (minutes):	1 to 20

NASA LANGLEY HYPERSONIC NITROGEN TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics Division
OTHER SOURCES OF INFORMATION: NASA TMX-1130; "Fifth Hypervelocity Techniques Symposium University of Denver, March 1967"	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is a discharge to vacuum type tunnel. The test section diameter is 19 inches and the test core size is approximately 8 inches at high pressure. An axially symmetric contoured nozzle is used. The test medium is nitrogen which is heated by a tungsten grid resistance heater. The tunnel exhausts into a 100-foot diameter vacuum sphere.

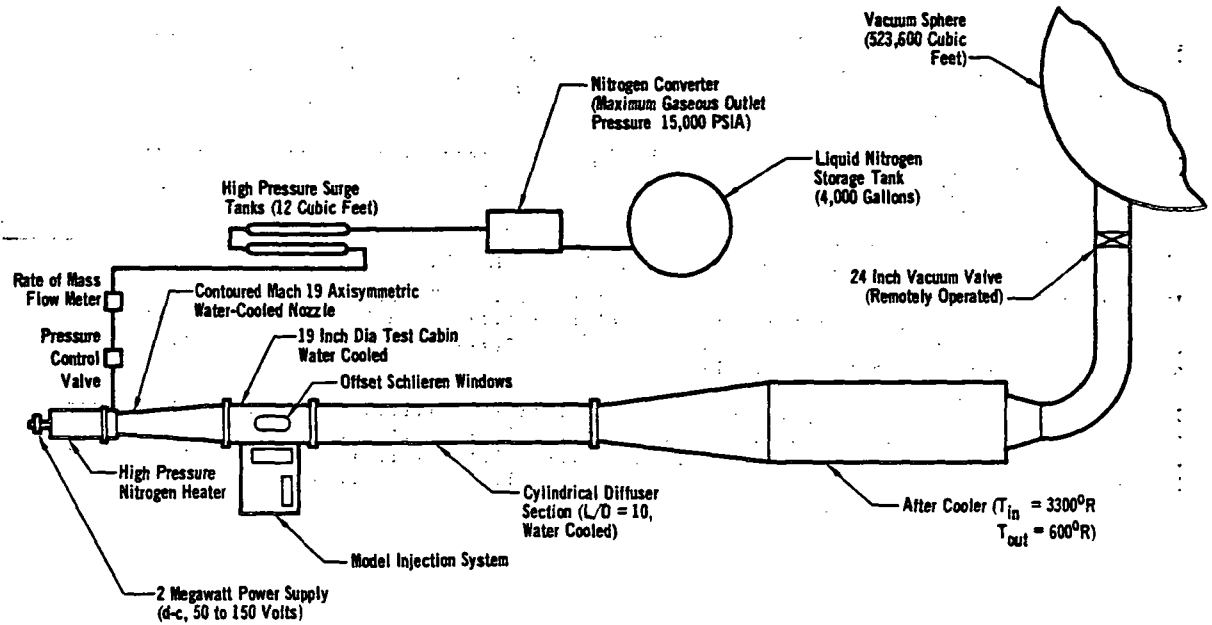
TESTING CAPABILITIES: This facility is capable of heat transfer, pressure, and force studies. Model mounting consists of variable angle sting and strut and a 2000 psi hydraulic quick-injection system. Flow visualization consists of an electron beam type system. Data are recorded with 100 channels on a Beckman recorder and reduced off site. This facility is capable of two runs per day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1964 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS: Not Available	LOCATION:

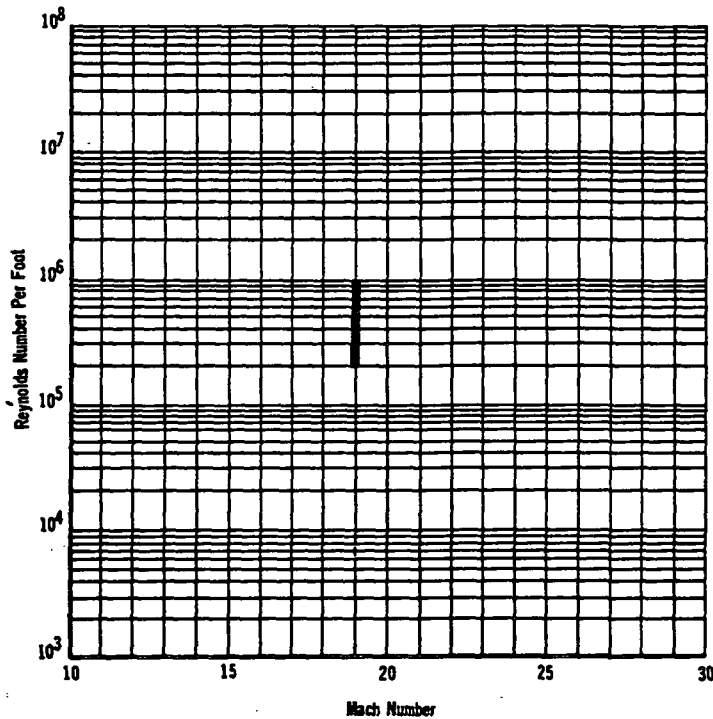
PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

FACILITY PERFORMANCE DATA



Mach Range:	19
Reynolds Number ($\times 10^6/\text{ft}$):	.2 to 1.00
Total Pressure (psia):	3000 to 10,000
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	2800 to 3500
Run Time (minutes):	Up to 120

NASA LANGLEY MACH 8 VARIABLE-DENSITY HYPERSONIC TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics Division
OTHER SOURCES OF INFORMATION: NASA TN D-2417, August 1964 NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an intermittent blowdown to atmosphere or vacuum type facility. The test section diameter is 18 inches; and the test core diameter is 4 inches to 14 inches, depending on pressure. The tunnel has an axially symmetric contoured nozzle. The test medium is air and is heated by electrical resistance heaters. The tunnel exhausts into either a vacuum tank or the atmosphere.

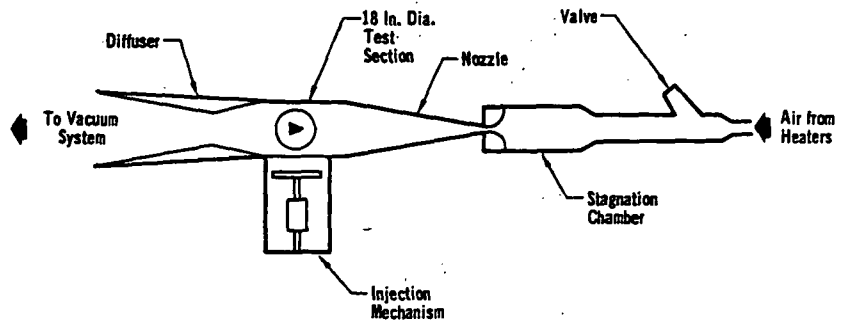
TESTING CAPABILITIES: This facility is capable of fundamental aerodynamic and fluid dynamic investigations over large Reynolds number ranges using pressure and heat-transfer measurements. Model mounting consists of sting mount with injection mechanism. Pressure and heat transfer data are reduced on a Beckman 210 Automatic Data Reduction System (98 channels). This facility is capable of 10 to 20 runs per day.

FACILITY COST HISTORY

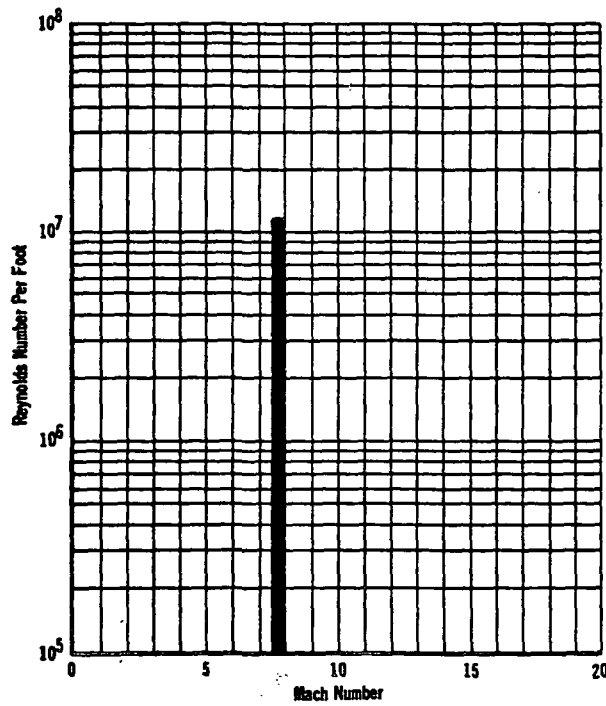
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1960 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	7.5 to 8
Reynolds Number ($\times 10^6/\text{ft}$):	.1 to 12
Total Pressure (psia):	15 to 2930
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	1160 to 1510
Run Time (seconds):	90 to 600

NASA LANGLEY 1-FOOT HYPERSONIC ARC TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics Division
OTHER SOURCES OF INFORMATION: "A Calibration and Diagnosis of the Test Stream of an Electric Arc-Heated Wind Tunnel"; An MS Thesis by Robert W. Guy, Sept. 1969; NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an arc discharge to atmosphere type tunnel. The test section is 1 foot in diameter and the test core is approximately 4 to 5 inches in diameter. The tunnel has a conical nozzle with .125 inch diameter to .140 inch diameter throats and exhausts through a steam ejector into the atmosphere. The test medium is usually air heated by an electric arc with a 1.5 megawatt dc power supply. Gases and combination of gases such as N₂, N₂-CO₂, N₂-CO₂-He have been used in the studies of kinetics of lasers.

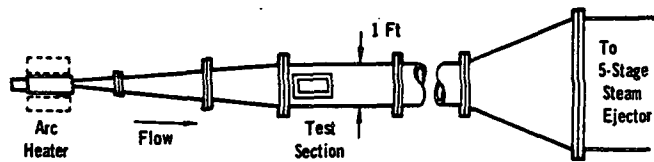
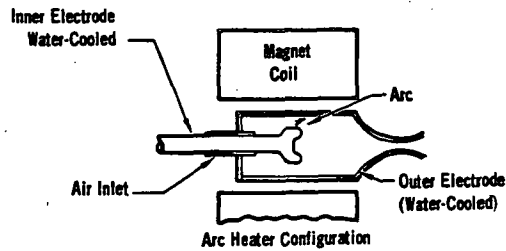
TESTING CAPABILITIES: This facility is capable of force, pressure, heat transfer, and flow kinetic studies at moderate enthalpies and low densities. Electron beam is available for flow visualization. Model mounting consists of fixed supports from tunnel sides and floor with variable angle-of-attack capabilities. Data are recorded with 52 channels on a CEC oscillograph. This facility is capable of 1 to 4 runs per day.

FACILITY COST HISTORY

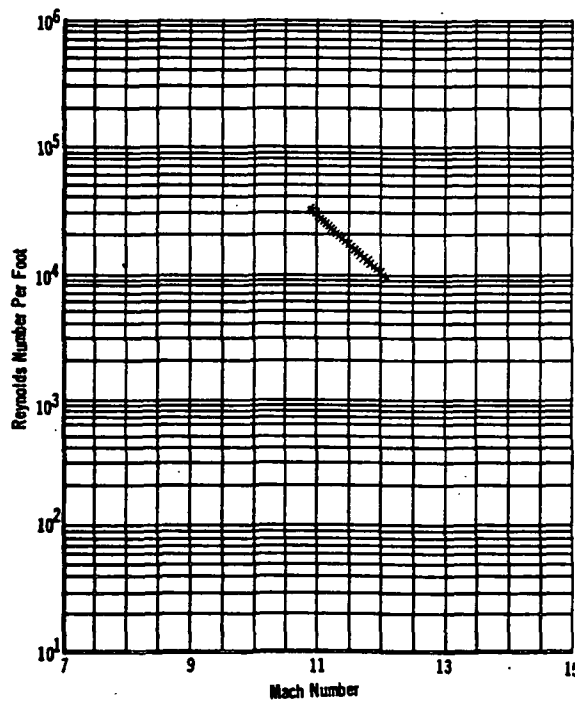
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR:	COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$	
IMPROVEMENTS AND COSTS:	LOCATION:	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	11 to 12
Reynolds Number ($\times 10^6/\text{ft}$):	.01 to .02
Total Pressure (psia):	125 to 400
Dynamic Pressure (psf):	10 to 14
Total Temperature ($^{\circ}\text{R}$):	8100
Run Time (seconds):	20 to 900

NASA LANGLEY MACH 6 HIGH REYNOLDS NUMBER TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics Division
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The tunnel is equipped with a flow switching valve and by-pass line to give a fast start capability. The nozzle is axially symmetric contoured with a low flow turning angle to minimize pressure gradient effects on the wall boundary layer. This facility is equipped with two different interchangeable test sections. One test section has schlieren windows and a model injection mechanism capable of rapidly injecting 4-foot long models for configuration and heat transfer studies at Reynolds numbers up to 200×10^6 . The other test section is for tunnel wall boundary layer studies using heat transfer, skin friction, pitot survey, and total temperature survey measurements over a length of 12 ft and Reynolds numbers up to 1.2×10^9 . The tunnel test section diameter is approximately 12 inches. The test gas is air heated by electrical resistance heaters.

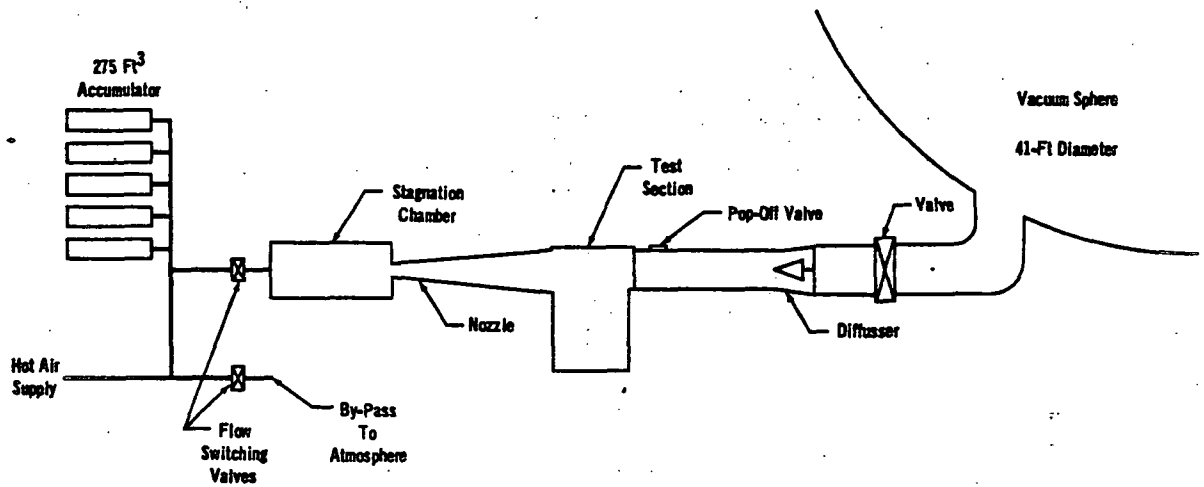
TESTING CAPABILITIES: This facility is capable of fundamental aerodynamic and fluid dynamic investigations over large Reynolds number ranges. Major support components are the central data reduction system and tie-ins, high pressure air compressor station and the 41-foot vacuum sphere system.

FACILITY COST HISTORY

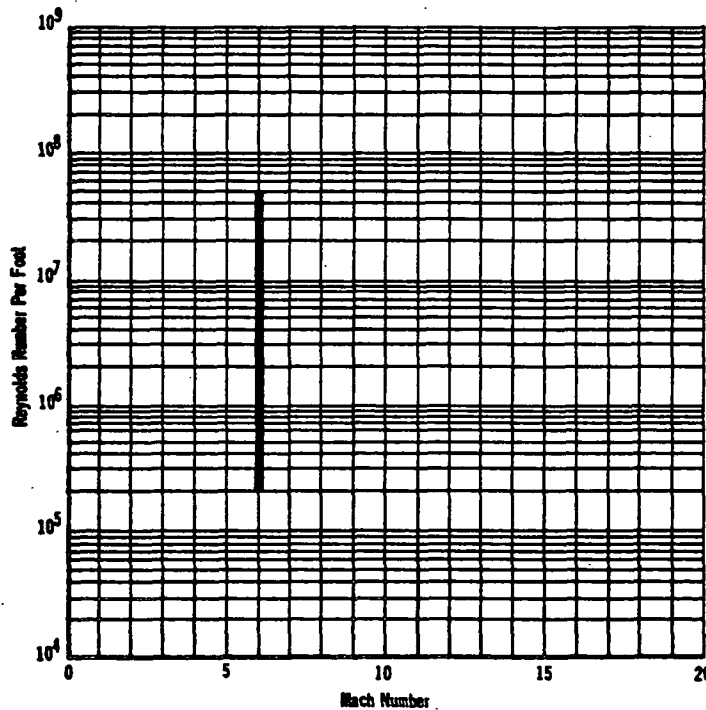
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1967 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHMATIC



FACILITY PERFORMANCE DATA



Mach Range:	6
Reynolds Number($\times 10^6/\text{ft}$):	.1 to 50
Total Pressure (psia):	50 to 3000
Dynamic Pressure (psf):	168 to 10,080
Total Temperature (°R):	700 to 1000
Run Time (seconds):	90 to 600

NASA LANGLEY 11-INCH HYPERSONIC TUNNEL

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics Division
OTHER SOURCES OF INFORMATION: NACA TN 2171, September 1950; NASA TR R-22, 1959; NASA TMX-1130	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Coda 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility has an eleven inch test section and a four to six inch test core. There are two interchangeable contoured air nozzles. Mach number 6.8 nozzle is two dimensional, and the Mach number 9.6 nozzle is three dimensional. Air runs are heated by an electrical resistance heater.

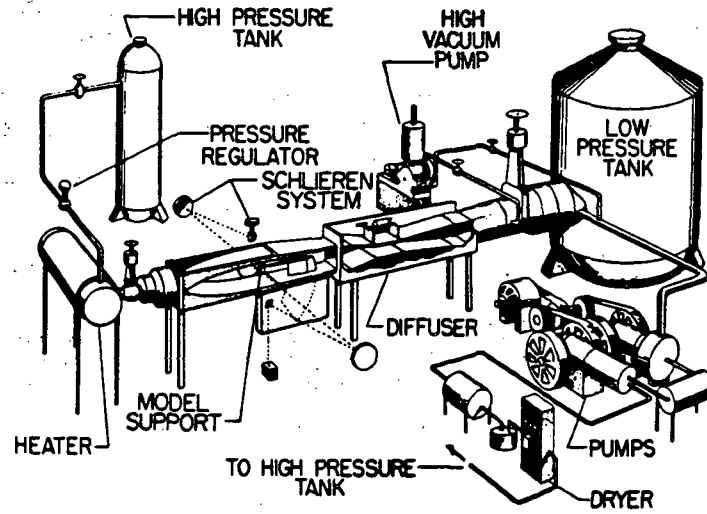
TESTING CAPABILITIES: This facility is capable of pressure investigation; heat transfer studies, and force testing with air as the test media. Model mounting consists of sting and wall mount. Angle of attack, 0° to 90°, true yaw angle, +10° -10°. Data are reduced off site with a CDC 6600 computer system.

FACILITY COST HISTORY

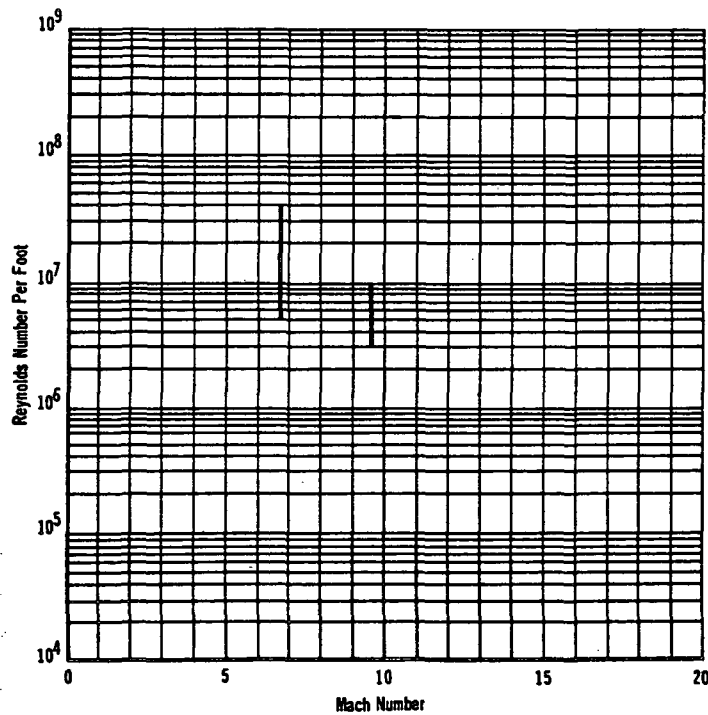
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1949 COST \$ ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: IMPROVEMENTS AND COSTS:	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: The high pressure tank is presently pumped up by a hookup to a 5000 psi dry air supply.

J. SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	6.8, 9.6
Reynolds Number ($\times 10^6/\text{ft}$):	.3 to 4
Total Pressure (psia):	70 to 700
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	Not Available
Run Time (seconds):	70 to 100

NASA LANGLEY HOT GAS RADIATION RESEARCH FACILITY

REPORTING INSTALLATION: NASA Langley Research Center Aero Physics Division Hampton, Virginia 23365	STATUS OF FACILITY: Construction COGNIZANT ORGANIZATIONAL COMPONENT: Aero Physics
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility consists of an expansion tube and a shock tube. The expansion tube, or expansion tunnel when a nozzle is employed preceding the test section, generates a very short duration high velocity flow with ambient properties of planetary atmospheres. The expansion tube design operating range for complete earth atmosphere duplication is bounded at the high velocity end by test section velocities of approximately 25,000 feet per second and 45,000 feet per second at altitudes of 100,000 feet and 250,000 feet, respectively. These operating limits may be increased by relaxing requirements on complete ambient duplication and using simulation techniques. The expansion tube will be driven by either (a) helium heated by the arc discharge of up to 10 million joules or (b) hydrogen heated with internal resistance heaters. The driver pressure chamber is limited to 20,000 psi. The shock tube has a 6-inch diameter driver capable of pressures up to 45,000 psi. The helium driver gas is heated by an arc discharge with energies up to 5×10^6 joules. The 6-inch diameter driven section is 50 feet long and is followed by a 4-foot diameter test section and a 12-inch diameter 10-foot long dump tank. Design conditions for the shock tube predict shock wave speeds from 30,000 to 50,000 feet/second into ambient densities corresponding to the earth's atmosphere at 50,000 and 120,000 feet, respectively. The use of either the reflected shock or model stagnation point techniques will result in greatly increased equivalent flight velocities which will be attainable at lower altitudes.

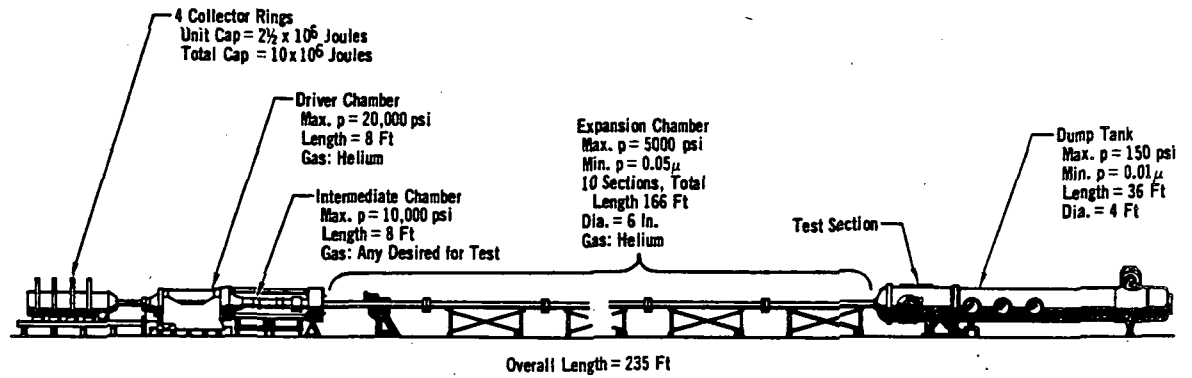
TESTING CAPABILITY: This facility is capable of: flow field phenomena, radiation heating distribution to a flight vehicle; basic radiative properties of gases at a given chemical and thermodynamic state; convective heat transfer. In the expansion tube mode the flow about fixed models located in test section will be investigated using instrumentation mounted both on-board and external to the models. Spectral and integrated radiation measurements together with studies of the model external flow fields will be prime objectives of experiments. Studies of spectral and total hot gas radiation as well as convective heat transfer will be primary functions of the shock tube. Data recording consists of oscilloscopes.

FACILITY COST HISTORY

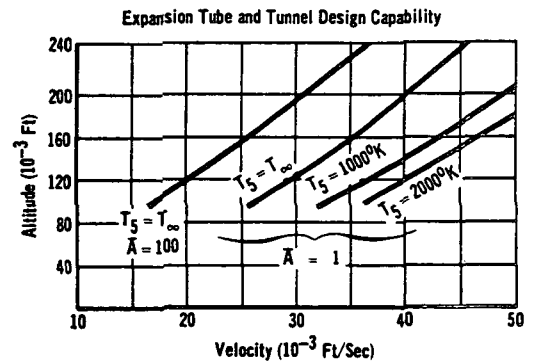
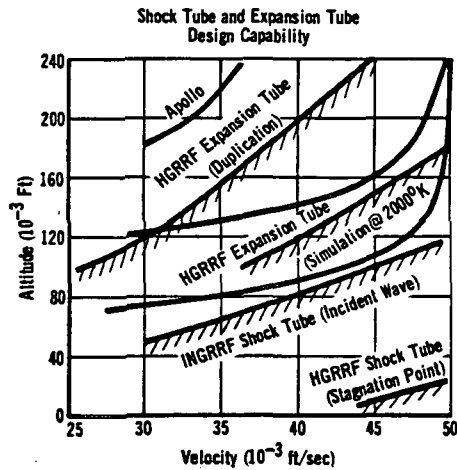
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1966 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



NASA LANGLEY ENTRY STRUCTURES FACILITY

REPORTING INSTALLATION: NASA Langley Research Center Structures Research Division Hampton, Virginia 23365	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Structures Research Division
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Chief, Research Models and Facilities Division Code 56.000 Phone: (703) 827-2045

DESCRIPTION AND TESTING CAPABILITIES

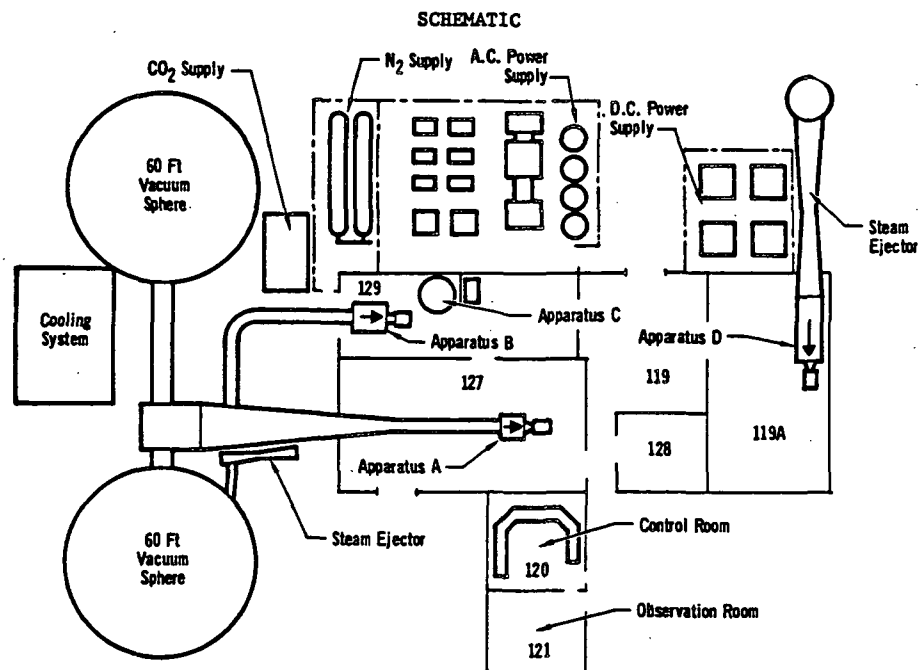
FACILITY DESCRIPTION: This total facility comprises four arc-powered apparatus producing environments of high temperature, and high velocity gas flow of controlled composition. Major support components consist of: 12 mW power system ac or dc; 234,000 cu ft vacuum storage system; 3500 gpm low pressure water system; 500 gpm medium pressure water system; gas flow control system; three stage steam ejector (Apparatus D only); and the Langley Control Data Recording and Reduction Center.

TESTING CAPABILITIES: This facility is used for the evaluating of the performance of heat shield materials for all types of entry vehicles.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1960 COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	
LOCATION:	

PLANS FOR FACILITY IMPROVEMENTS: None



FACILITY PERFORMANCE DATA

	Apparatus A	Apparatus B
Enthalpy Range (Btu/lb _m):	9000 to 16,000	1000 to 5000
Heating Rate Parameter (Btu/ft ^{3/2} -sec):	70 to 200	10 to 200
Model Stagnation Pressure (atmospheres):	.03 to .12	.05 to 4
Maximum Specimen Diameter (inch):	2.5	3
Maximum Running Time (second):	300	100 to 500
Number of Test Per Day:	6	6
	Apparatus C	Apparatus D
Enthalpy Range (Btu/lb _m):	1000 to 4000	2500 to 15,000
Heating Rate Parameter (Btu/ft ^{3/2} -sec):	40 to 400	20 to 100
Model Stagnation Pressure (atmospheres):	1	.015 to .07
Maximum Specimen Diameter (inch):	3	2
Maximum Running Time (second):	Continuous	Continuous
Number of Test Per Day:	8	4

NASA MSC 10-MEGAWATT ARC TUNNEL FACILITY

REPORTING INSTALLATION: NASA Manned Spacecraft Center Building 222, Code ES56 Houston, Texas 77058	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Structures and Mechanics Division - Code ES Thermal Technology Branch - Code ES5 Experimental Heat Transfer Section - Code ES56
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Head, Experimental Heat Transfer Section - Code ES56 NASA Manned Spacecraft Center Phone: (713) 488-3481

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The MSC 10 MW arc tunnel facility is an electric arc-heated supersonic tunnel which employs two 10 MW dc arc heaters. Free stream Mach numbers from 2 to 8 may be obtained using interchangeable nozzle throats and nozzles with exit diameters of 5, 10, 15, 20, and 25 inches. A 10 MW dc silicone controlled rectifier power supply is used and is rated for continuous operation at 10 MW for one hour. The test section is 8-feet in diameter with a 5 to 25 inch diameter test core. The test gas volume is 50,000 cu ft at 2300 psia.

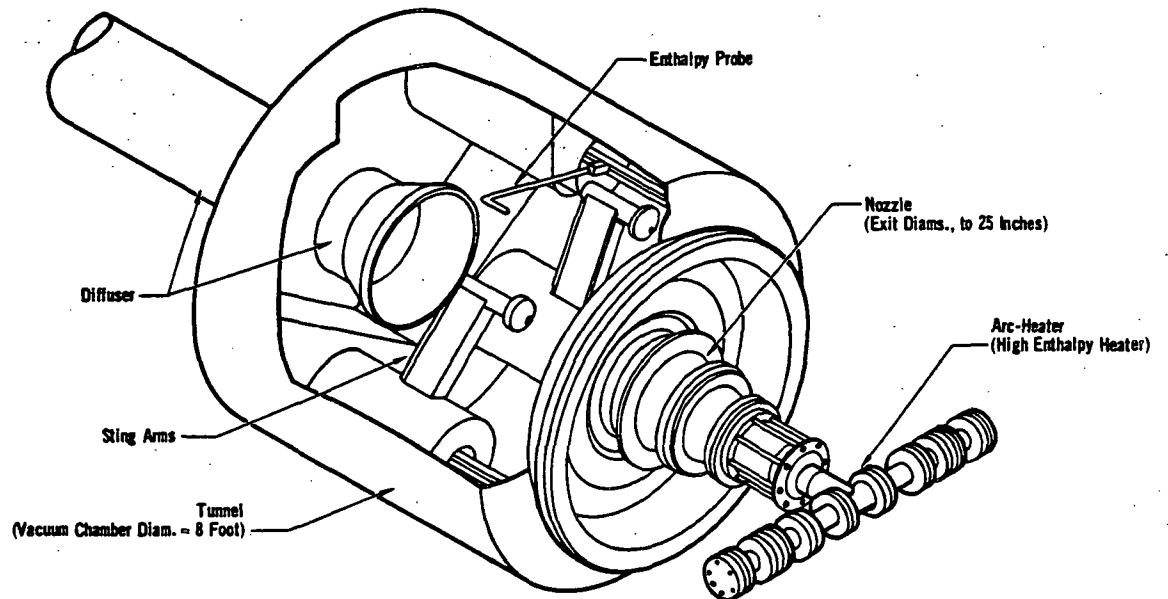
TESTING CAPABILITIES: This facility has been used for thermal evaluation of thermal protection systems under simulated entry environment conditions; aerothermodynamic tests on scale models of manned spacecraft for the purpose of measuring heat transfer rates and distributions. The test chamber contains two insertion arms which have a variable injection speed control. A separate insertion system accommodates specialized probes for making pitot pressure, heat flux, or enthalpy distribution measurements. Data are recorded on (150 channels) analog to digital magnetic tape and reduced on site with a UNIVAC-1108. This facility is capable of 4 runs per day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1964 COST \$2,894,000 ESTIMATED REPLACEMENT VALUE \$3,900,000
CONTRACTOR: AVCO Corp.; Baxter Construction Co. IMPROVEMENTS AND COSTS: Not Available	LOCATION: Houston, Texas (Both)

PLANS FOR FACILITY IMPROVEMENTS: Upgrading Arc Jets \$1,000,000.

SCHMATIC



FACILITY PERFORMANCE DATA

Operating Envelope

(Not Available)

Mach Range:	2 to 8
Reynolds Number ($\times 10^6/\text{ft}$):	.001 to .1
Total Pressure (psia):	.0735 to 147
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	3000 to 20,000
Run Time (seconds):	300 to 3600

NASA MSC 1.5 MEGAWATT ARC TUNNEL FACILITY

REPORTING INSTALLATION: NASA Manned Spacecraft Center Code ES56, Building 262 Houston, Texas 77058	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Structures and Mechanics Division - Code ES Thermal Technology Branch - Code ES5 Experimental Heat Transfer Section - Code ES56
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Head, Experimental Heat Transfer Section - Code ES56 Phone: (713) 488-3481

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The MSC 1.5 MW arc tunnel facility is an electric arc-heated supersonic tunnel which employs one 1 MW dc arc heater. Free stream Mach numbers from 4 to 5 may be obtained using interchangeable throats and a nozzle with an exit diameter of 6 inches. A 1.5 MW dc saturable core reactor type power supply is used and is rated for continuous operation at 1 MW for one hour and operation for 15 minutes at 1.5 MW. The test section is 6-feet in diameter with a test core of 4 inches. The test gas volume is 10,000 cu ft at 340 psia.

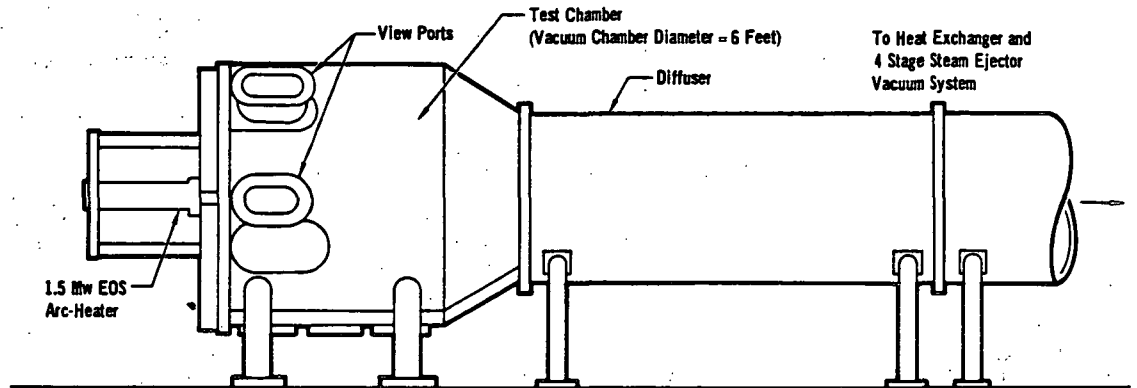
TESTING CAPABILITIES: This facility is particularly adapted for performing thermal evaluation tests on small samples of manned spacecraft thermal protection materials under simulated entry environment conditions associated with earth re-entry from a lunar or earth orbit mission. The facility provides partial simulation of the entry environment associated with earth re-entry from a Mars return mission. The test chamber contains two insertion arms which have a variable injection speed control. A separate insertion system accommodates specialized probes for making pitot pressure, heat flux, or enthalpy distribution measurements. Motion pictures and spectrographs are available. Data are recorded with 50 channels of analog to digital magnetic tape and reduced on site with a Univac 1108 reduction system. The time cycle for data processing is normally 48 hours or 24 hours at maximum priority.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): Not Available	CONSTRUCTION YEAR: 1963 COST \$165,979 ESTIMATED REPLACEMENT VALUE \$500,000
CONTRACTOR: Warrior Construction Co.	LOCATION: Houston, Texas
IMPROVEMENTS AND COSTS: (1964) Extension of radiant heating and acoustics, Cost \$4300; (1965) Modification to central heating and cooling, Cost \$10,032; (1966) 1.5 arc jet entry environment Sim and Water Modification, Cost \$194,418; (1968) Improvement, Cost \$5110.	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA

Operating Envelope

(Not Available)

Mach Range:	4 to 5
Reynolds Number ($\times 10^6/\text{ft}$):	.0005 to .05
Total Pressure (psia):	0 to 147
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	23,000
Run Time (seconds):	900 to 3600

NOL HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: U.S. Naval Ordnance Laboratory Silver Spring, Maryland 20910	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Applied Aerodynamics Division Aerodynamics Department
OTHER SOURCES OF INFORMATION: Report No. NOLTR 68-187 NOLTR 67-27	LOCAL OFFICE TO CONTACT FOR INFORMATION: Building 406 Phone: (301) 434-7100, ext 564 or 570

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: The facility is comprised of two parallel blowdown tunnels: one for operation at Mach 5 to 10 using air as a fluid and another for Mach 12 and 17 using nitrogen. Air is stored at 5000 psi in a 42,000-lb capacity field and is heated with a pebble bed supplemented (at Mach 9 and 10) with an electric resistance heater. Nitrogen is stored at 15,000 psi in a 26,000-lb capacity field and is heated with a graphite electric resistance heater. Expansion nozzles are precision-contoured producing high-quality test jets of approximately 1-1/2 ft in diameter.

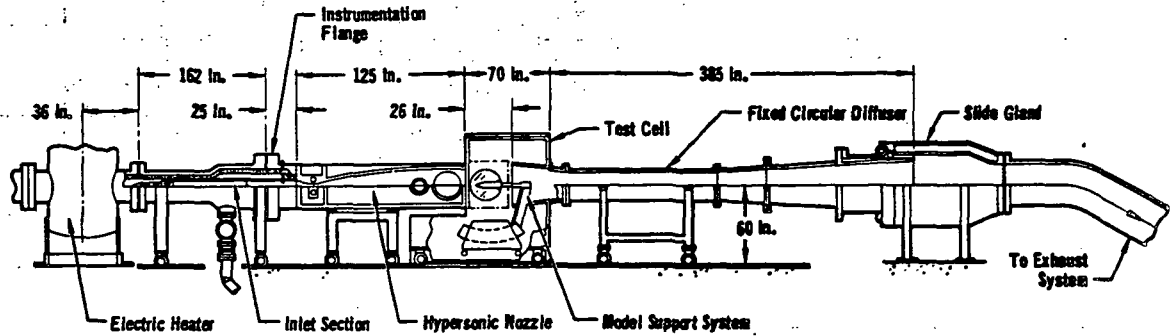
TESTING CAPABILITIES: The tunnel is used for aerodynamic, heat transfer, ablation and combustion studies. An outstanding feature of this tunnel is its capability to provide simulated low-altitude (sea level at Mach 5) hypersonic flight conditions. At Mach numbers up to 8 the tunnel can exhaust directly into the atmosphere thus permitting safe operation for combustion testing. For heat transfer or ablation studies use is made of a quick-acting model injection and retraction mechanism. The instrumentation system permits simultaneous measurement and recording of pressures (or temperatures) at up to 100 stations. The tunnel optical system consists of a high-quality 16-inch-diameter schlieren bench and a variety of high-speed cameras.

FACILITY COST HISTORY

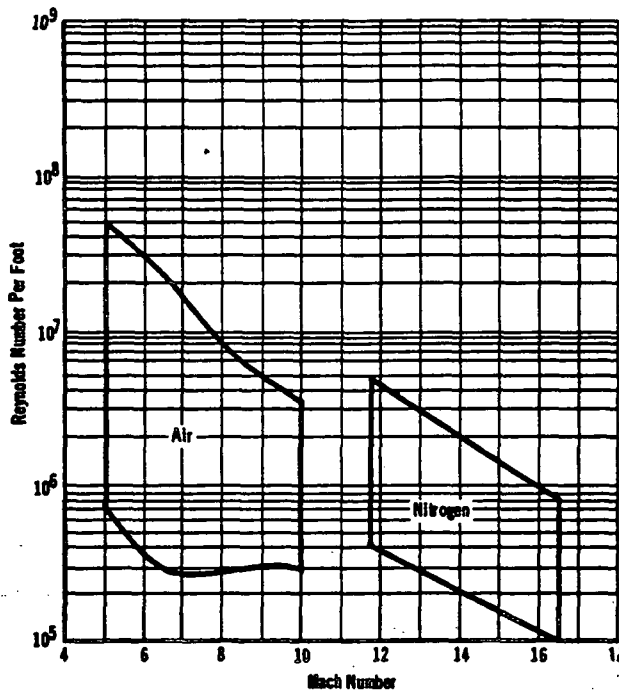
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$9600	CONSTRUCTION YEAR: 1956 COST \$3,500,000 ESTIMATED REPLACEMENT VALUE \$6,200,000
CONTRACTOR: U.S. Naval Ordnance Laboratory IMPROVEMENTS AND COSTS: (1960-69) Technical Equipment (nozzles, heaters, etc.), Cost \$800,000; (1969-70) Mach 12 and 17 capability, Cost \$1,000,000.	LOCATION: White Oak, Maryland

PLANS FOR FACILITY IMPROVEMENTS: High Reynolds number - Mach 3 and 4 capability.

SCHEMATIC



FACILITY PERFORMANCE DATA



(Air)

Mach Range: 5,6,7,8,9,10

Reynolds Number ($\times 10^6/\text{ft}$): .3 to 50

Total Pressure (psia): 14.7 to 2200

Dynamic Pressure (psf): 50 to 7000

Total Temperature ($^{\circ}\text{R}$): 700 to 2000

Run Time (minutes): .5 to continuous

(Nitrogen)

Mach Range: 12,17

Reynolds Number ($\times 10^6/\text{ft}$): .1 to 5

Total Pressure (psia): 735 to 10,000

Dynamic Pressure (psf): 2000 to 4000

Total Temperature ($^{\circ}\text{R}$): 2000 to 4000

Run Time (minutes): 4 to continuous

NOL 3-MEGAWATT ARC TUNNEL

REPORTING INSTALLATION: U.S. Naval Ordnance Laboratory Silver Spring, Maryland 20910	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Aerophysics Division, Aerodynamics Department
OTHER SOURCES OF INFORMATION: Report No. NOLR 66-80	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation), Bldg. 424 Phone: (301) 434-7100, ext. 625

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is an electric discharge type wind tunnel with an open jet test section and up to a 10-inch test core. A 3-phase ac arc heats the air to stagnation temperatures of 10,000°R. This facility is equipped with contoured, conical and sonic type nozzles. The test medium is air or nitrogen.

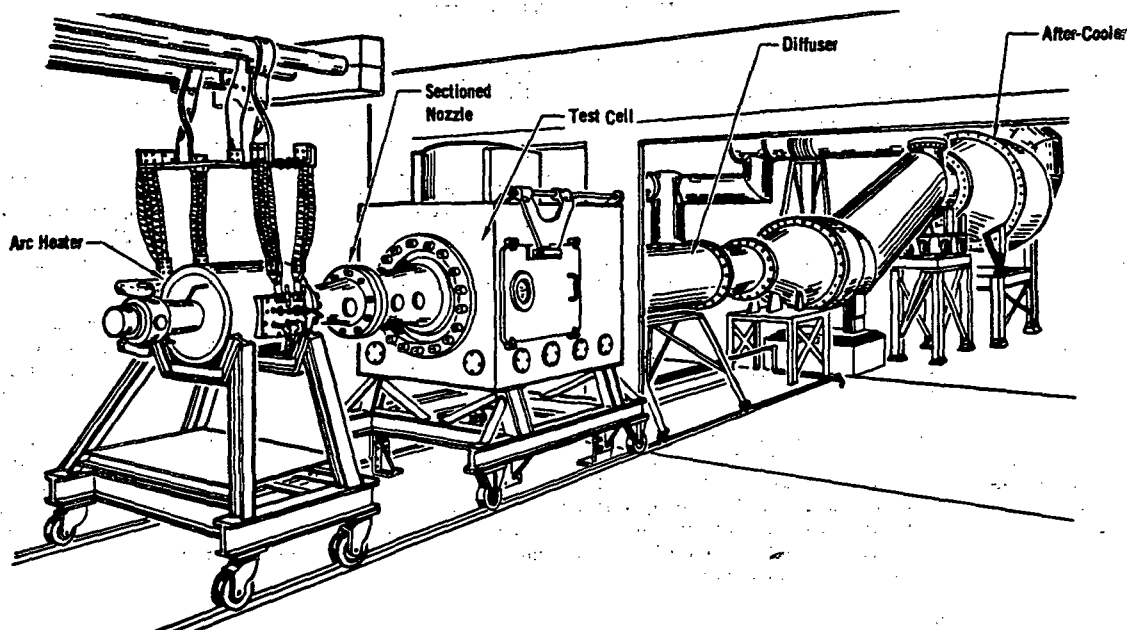
TESTING CAPABILITIES: This tunnel is used primarily for ablation studies, transpiration cooling studies, material evaluation studies, skin-friction measurements and special gas dynamics problems. The characteristics of hot flow are examined with specially cooled pitot and static probes, calorimeter-type heat-transfer gages and an infrared radiation pyrometer. Model mounting consists of strut, a system with 2-D movement, and one with axial traverse and quick injection. Data are recorded with 72 channels on light beam oscillographs and reduced on site part manual and part with time sharing computer. This facility is capable of 1 to 7 runs per day.

FACILITY COST HISTORY

AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1600	CONSTRUCTION YEAR: 1961 COST \$ 256,000 ESTIMATED REPLACEMENT VALUE \$1,200,000
CONTRACTOR: U.S. Naval Ordnance Laboratory IMPROVEMENTS AND COSTS: (1964) Technical Equipment, Cost \$624,000.	LOCATION: Silver Spring, Maryland

PLANS FOR FACILITY IMPROVEMENTS: Increased running time--new vacuum storage capability--new arc heater.

SCHEMATIC



FACILITY PERFORMANCE DATA

Operating Envelope

(Not Available)

NOTE: Operating envelope consists of Mach Number vs Reynolds Number per foot

Mach Range:	1 to 10
Reynolds Number ($\times 10^6/\text{ft}$):	.01 to 1
Total Pressure (psia):	150 to 1000
Dynamic Pressure (psf):	Not Available
Total Temperature ($^{\circ}\text{R}$):	2700 to 10,800
Run Time (seconds):	4 to 15

NSRDC 13.5-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Naval Ship Research and Development Center Department of Aerodynamics, Code 681 Washington, D.C. 20007	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Engineering and Facilities Division, Code 680
OTHER SOURCE OF INFORMATION: Aero Reports 1027, 1070	LOCAL OFFICE TO CONTACT FOR INFORMATION: Facilities Branch Code 681 Phone: (301) 995-3147

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This wind tunnel is an intermittent blowdown to vacuum type facility. It projects a stream of high pressure storage air through an axisymmetric nozzle of 13-1/2 inch exit diameter and through an open jet test section exhausting into two evacuated spheres. The test core is 12.1 inches in diameter. The storage air is compressed, dried by silica gel, and then heated to the desired temperature by the pebble bed heater. The test medium is air.

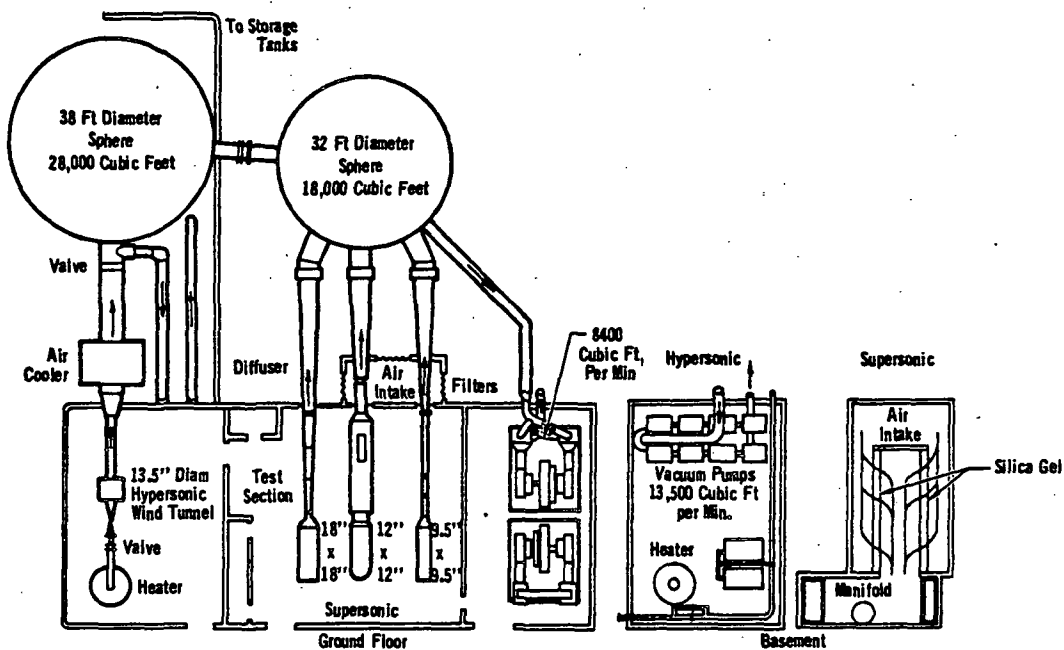
TESTING CAPABILITIES: This facility has been used for all types of testing including high temperature heat transfer investigations. A wide variety of strain gage balances, some water-cooled, are available for force investigations. A wide latitude of flow conditions can be obtained in the test section by varying the supply pressure and the supply temperature over the ranges listed above. Not every pressure and temperature combination can be selected at every Mach number if excessive mass flow and/or liquefaction conditions are to be avoided. A motor driven angle of attack sector allows a complete angle sweep to be obtained during one run. The open-jet feature allows the model to be inserted or withdrawn after tunnel flow is established avoiding starting and stopping loads. The open-jet feature also allows accurate determination of initial conditions and provides for cooling the model to some reference temperature between runs. Data are recorded on (50 channels) Beckman 210 recorder and reduced on site with an SDS 930 digital computer. This facility is capable of eight runs per day.

FACILITY COST HISTORY

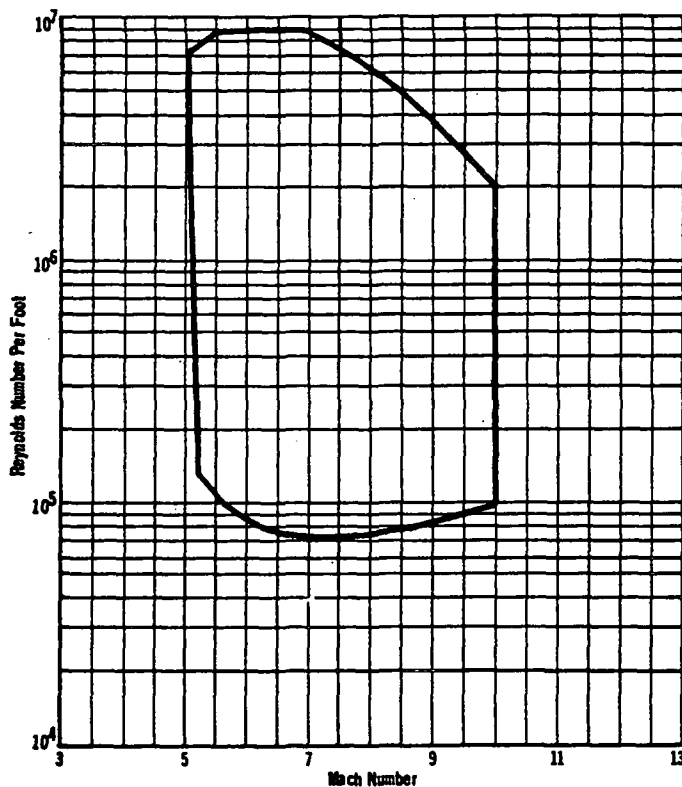
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$600	CONSTRUCTION YEAR: 1960 COST \$800,000 ESTIMATED REPLACEMENT VALUE \$950,000
CONTRACTOR: IMPROVEMENTS AND COSTS:	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: Extension to Mach number of 12 capability.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	5 to 10
Reynolds Number ($\times 10^6/\text{ft}$):	.07 to 9
Total Pressure (psia):	15 to 600
Dynamic Pressure (psf):	0 to 430
Total Temperature ($^{\circ}\text{R}$):	540 to 2500
Run Time (seconds):	90

NORTH AMERICAN ROCKWELL/LOS ANGELES 1-FOOT HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: North American Rockwell Corporation International Airport Los Angeles, California 90009	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Los Angeles Division, Research and Engineering Department 056
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: Wind Tunnel Programs and Testing 5701 W. Imperial Hwy; Los Angeles, Calif. 90009 Phone: (213) 670-9151, ext 3421

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This facility is of the intermittent blowdown type with a 12-inch test core and equipped with four axisymmetric contoured nozzles to obtain Mach numbers of 3.5, 5, 7, and 9. Supply pressure for the tunnel is obtained from a 4000 cu ft air storage vessel maintained at 350 psia. Pressure at the nozzle stilling chamber is automatically regulated for each blow at any preset pressure up to 330 psia. Temperature of the supply air can be automatically controlled at any value from ambient up to 1500°F by a mixing valve which bypasses the required amount of air through the 1500°F electric storage heater. A 24,000 cu ft vacuum sphere provides sufficient pressure ratio to maintain hypersonic flow.

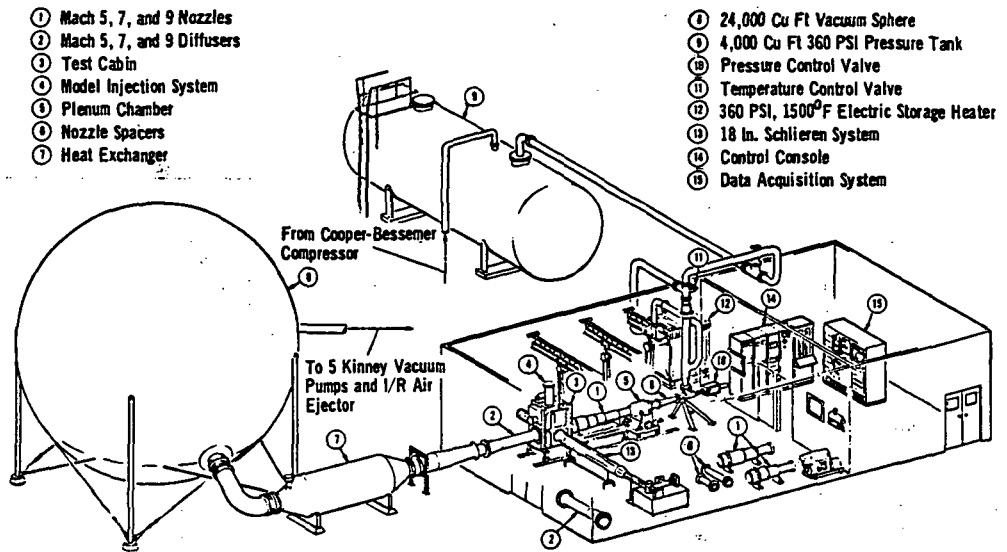
TESTING CAPABILITIES: This tunnel is capable of basic force and stability, pressure distribution and store ejection type tests. Each of the four nozzles provides a useable test core nominally 12 inches in diameter which extends 18 inches aft of the nozzle exit. The model injection and support system is designed to allow starting of the tunnel with the model out of the flow, inject the model in one second, and pitch the model through an angle of attack of -15° to +35° at a rate of 2 degrees per second. Force and moment data may be obtained from a .75 inch diameter six component water cooled balance and recorded through a 50 channel automatic data acquisition system. Blow times ranging up to 60 seconds permit pressure measurements through a scanivalve unit. Flow visualization photographs may be made through the 18 inch diameter side windows utilizing the double pass schlieren system. Data are reduced on an IBM 360-50 (off site) computer through a local terminal.

FACILITY COST HISTORY

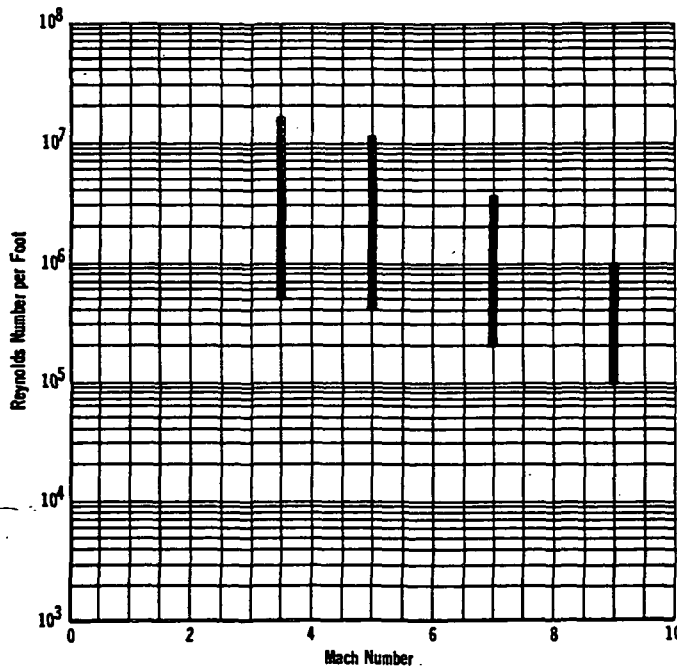
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1965 COST \$375,000 ESTIMATED REPLACEMENT VALUE \$500,000
CONTRACTOR: North American Rockwell and Various Others LOCATION: Los Angeles, California IMPROVEMENTS AND COSTS: (1966) Mach 3.5 Nozzle, Cost \$14,000	

PLANS FOR FACILITY IMPROVEMENTS: None.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	3.5, 5, 7, 9
Reynolds Number ($\times 10^6/\text{ft}$):	.1 to 16
Total Pressure (psia):	20 to 330
Dynamic Pressure (psf):	15 to 2000
Total Temperature ($^{\circ}\text{R}$):	540 to 1760
Run Time (seconds):	30 to 60

NORTHROP 30-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Northrop Corporation Aircraft Division 3901 W. Broadway Hawthorne, California 90250	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT:
OTHER SOURCES OF INFORMATION:	LOCAL OFFICE TO CONTACT FOR INFORMATION: (Same as Reporting Installation) Phone: (213) 675-4611, ext 2554

DESCRIPTION AND TESTING CAPABILITIES

TESTING CAPABILITIES: The high speed test facility consists of two separate wind tunnel circuits operating from a common high pressure storage system. The trisonic circuit covers the testing range of Mach .2 through 1.35, 1.5, 2.0, and 3.0 while the hypersonic circuit has Mach number capabilities of 6.0, 10.0, and 14.0. Both tunnels are of the intermittent blowdown using interchangeable nozzles. The hypersonic circuit has a 30-inch diameter test section. A "free jet" test section is interchangeable with a "closed jet" section. The nozzles are of the interchangeable fixed block type. The hypersonic circuit is equipped with a 3000°F alumina pebble bed heater to raise the air temperature in order to prevent liquefaction. The heater also serves as the settling chamber for the hypersonic wind tunnel and is pressurized to the desired stagnation pressure by bleeding the high pressure storage air into it through a control valve at the bottom of the heater. A plug valve seating in the nozzle bellmouth is used to start and stop air flow in the hypersonic nozzles. To protect the axisymmetric nozzle throat region from high heat transfer rates during operation, unheated air is introduced through an annular slot located upstream of the throat section to provide an annular film to protect the throat from the high temperature air flow. The hypersonic flow is decelerated by a constant diameter diffuser and is cooled prior to emptying into the vacuum sphere by a heat sink comprised of a matrix of small pipes across which the flow must pass. Air is supplied to both circuits by a 2000 ft³ 3200 psig storage system. The air is supplied to the storage system by two Ingersoll-Rand compressor circuits arranged in parallel at a rate of one pound per second. The compressed air is filtered, dried, and delivered with a dew point of -140°F to the 2000 ft³ storage system, which consists of 4 banks of 15 bottles (torpedo flasks) each. Each bank can be pressurized or exhausted independently through isolation valves. The pressurization rate under normal operating conditions is approximately 300 psi per hour. The hypersonic circuit exhaust to a 100,000 cu ft vacuum sphere.

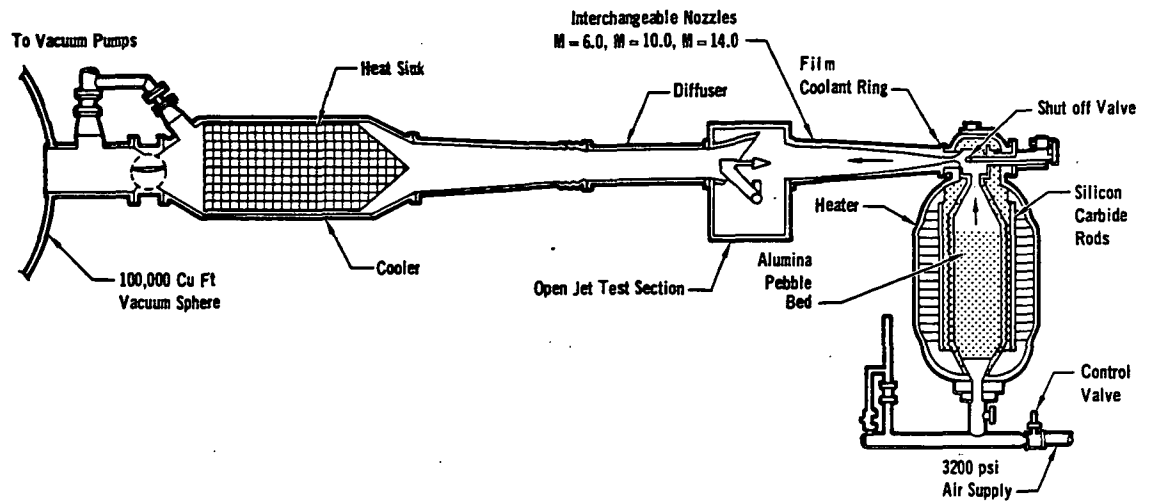
TESTING CAPABILITIES: The support system was designed to be installed and utilized in the trisonic tunnel circuit as well as in the closed jet circuit of the hypersonic wind tunnel. A minimum of installation and calibration time is involved in moving from one circuit to another. The system is basically a pitch and pause type which is controlled by the data acquisition equipment. Unique features include twenty preset model positions with a variable pause time (.01 to 1.0 second) and variable rate between positions (5 to 20 degrees per second). The system consists of a vertically translating strut with a sting mounting pod pivoting about a fixed location on the strut. Pitch capability of + 20 degrees, a roll range of 360 degrees, and a change in the pitch center of rotation through a range of 15 inches are attainable. A mechanical linkage between pod rotation and strut translation is variable in ratio to provide the variable model center of rotation. This variable ratio is provided by guiding the strut in roller bearings and controlling pod pitch angle with a parallelogram-type linkage. The model support system is computer controlled and may be operated in either the automatic or manual mode. With the system in either mode of operation, emergency home may be commanded to return the model to a preset condition. An 18-inch diameter optical quality glass window is located on each side of the test section for viewing through the schlieren optical system. The data processing for the facilities at the Northrop Norair Aerospacelabs Laboratories is handled through the high speed Central Data Acquisition System coupled to a Honeywell DDP 516 Computer.

FACILITY COST HISTORY

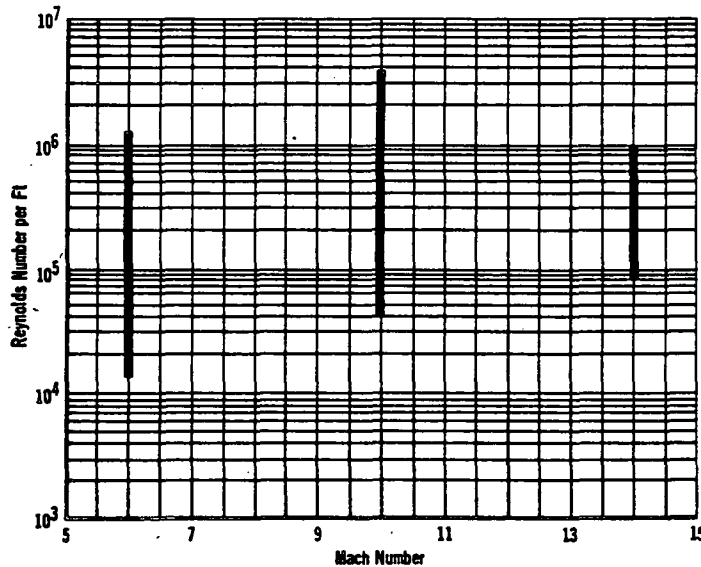
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: COST \$
CONTRACTOR:	ESTIMATED REPLACEMENT VALUE \$
IMPROVEMENTS AND COSTS: Not Available	LOCATION:

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range:	6, 10, 14
Reynolds Number ($\times 10^6/\text{ft}$):	.02 to 3.5
Total Pressure (psia):	15 to 3000
Dynamic Pressure (psf):	10 to 600
Total Temperature ($^{\circ}\text{R}$):	To 3200
Run Time (seconds):	25 (average)

SANDIA 18-INCH HYPERSONIC WIND TUNNEL

REPORTING INSTALLATION: Sandia Laboratories Sandia Base (9300), New Mexico 87115	STATUS OF FACILITY: Active COGNIZANT ORGANIZATIONAL COMPONENT: Experimental Aerodynamics Division, 9322
OTHER SOURCES OF INFORMATION: Sandia Laboratory Aerodynamic Test Facilities Report No. SC-4937(M), September 1963	LOCAL OFFICE TO CONTACT FOR INFORMATION: Experimental Aerodynamics Division (9322) Mr. W. H. Curry Phone: (505) 264-6775

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This tunnel is an intermittent, vacuum receiver exhaust, blowdown type with a test section 18 inches in diameter and a 15 inch test core nominally 48 inches in length. The energy source consists of 5200 cubic feet of air stored at 300 psia. The exhaust system consists of three 10,000 cubic foot vacuum tanks evacuated to less than .1 psia. The first tank is filled with approximately 150,000 quart paint cans to aftercool the tunnel exhaust and increase the run time. Axisymmetric nozzles are available at nominal Mach numbers of 5, 7.3, 9 and 11.3. The nozzles are mounted on a unique revolver arrangement which facilitates change of Mach number. The air is preheated through a gas-fired alumina pebble bed heater containing approximately 25,000 pounds of one inch diameter pebbles and capable of temperature to 3000°R.

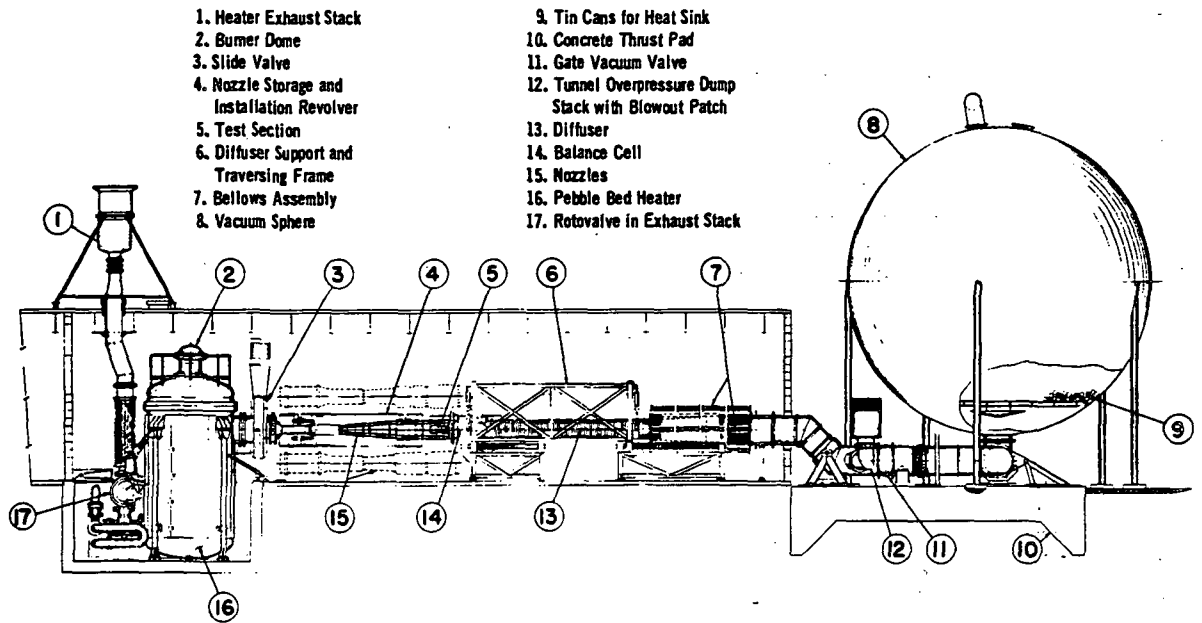
TESTING CAPABILITIES: This tunnel is capable of force and moment, pressure and dynamic stability testing. A model injection system is under development which will permit heat transfer testing. In addition, a modification is under way which will increase the capability to Mach 13.5 at a stagnation pressure of 3500 psi and improve Mach 11 operation to 1100 psi. Data are recorded on a computer-controlled, 5000 pts/sec (50 channel) system and reduced on a CDC 6600 off site system.

FACILITY COST HISTORY

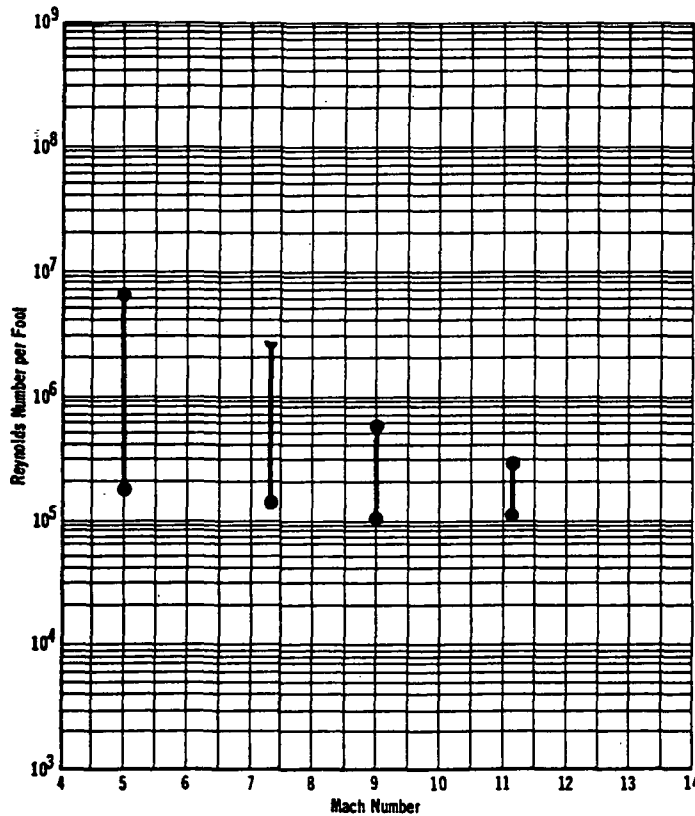
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT): \$1025	CONSTRUCTION YEAR: 1961 COST \$1,000,000 ESTIMATED REPLACEMENT VALUE \$2,000,000
CONTRACTOR: Numerous contractors; assembled by Sandia LOCATION: Sandia Base, New Mexico IMPROVEMENTS AND COSTS: (1963) Mach 5, 9, 11 addition, Cost \$75,000; High speed, computer-controlled data system, Cost \$250,000; (1963-69) Increased vacuum pumping capability, Cost \$200,000.	

PLANS FOR FACILITY IMPROVEMENTS: Mach 13.5 addition is under way. This will provide Mach 13.5 at stagnation pressures to 3500 psi and stagnation temperatures to 2350°R.

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 5, 7, 9, 11
 Reynolds Number ($\times 10^6/\text{ft}$): .11 to 6.78
 Total Pressure (psia): 25 to 275
 Dynamic Pressure (psf): .17 to 4.95
 Total Temperature ($^{\circ}\text{R}$): 640 to 3000
 Run Time (seconds): 45

UNIVERSITY OF MICHIGAN HOTSHOT WIND TUNNEL

REPORTING INSTALLATION: University of Michigan North Campus Ann Arbor, Michigan 48105	STATUS OF FACILITY: Stand-by COGNIZANT ORGANIZATIONAL COMPONENT: Aerospace Engineering
OTHER SOURCES OF INFORMATION: USAF ARL Report No. ARL-69-0089, June 1969 (Appendix A)	LOCAL OFFICE TO CONTACT FOR INFORMATION: Gas Dynamics Laboratory Phone: (313) 764-7200

DESCRIPTION AND TESTING CAPABILITIES

FACILITY DESCRIPTION: This is an arc discharge type wind tunnel. The conical test section is approximately 19 inches in diameter at the test section center line. The tunnel utilizes a 15° total angle axisymmetric conical nozzle with tungsten throat inserts. A cylindrical 20 inch diameter free jet test section is also available. This tunnel test medium is nitrogen or helium.

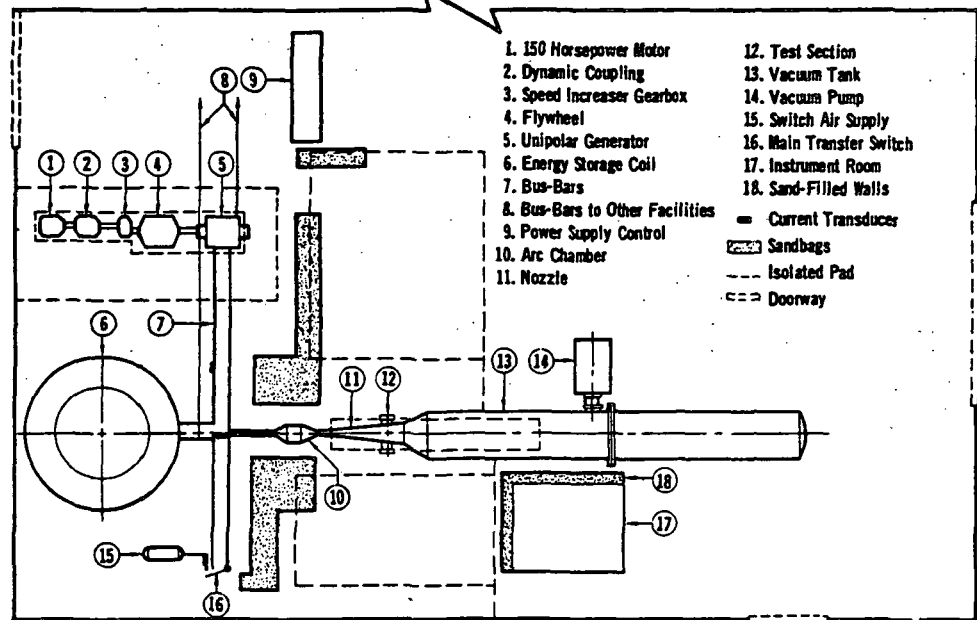
TESTING CAPABILITIES: Twelve channels of pressure and heat transfer instrumentation are used. Metal vapor in helium is used for condensation studies. A schlieren system is available for flow visualization.

FACILITY COST HISTORY

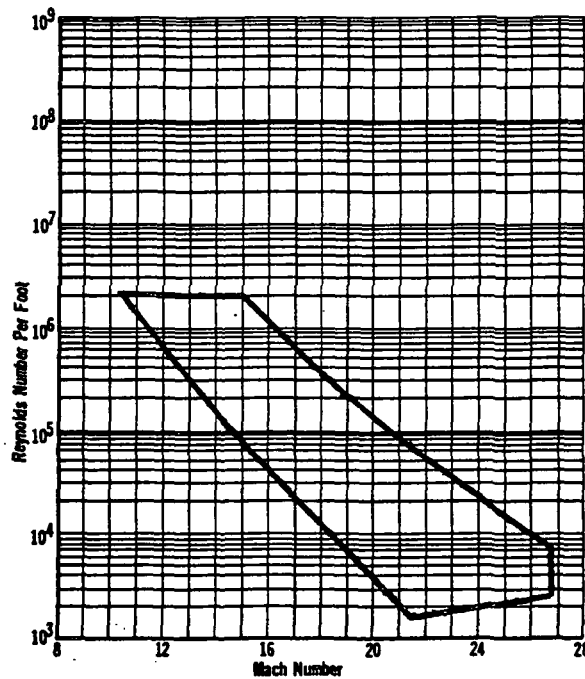
AVERAGE ESTIMATED OPERATING COST (TYPICAL 8 HOUR SHIFT):	CONSTRUCTION YEAR: 1962 COST \$500,000 ESTIMATED REPLACEMENT VALUE \$
CONTRACTOR: (Experimental Facility) University of Michigan LOCATION: Ann Arbor, Michigan IMPROVEMENTS AND COSTS: (Not Available)	

PLANS FOR FACILITY IMPROVEMENTS: None

SCHEMATIC



FACILITY PERFORMANCE DATA



Mach Range: 11 to 27

Reynolds Number ($\times 10^6/\text{ft}$): .0015 to 2

Total Pressure (psia): 0 to 15,000

Dynamic Pressure (psf):

Total Temperature ($^{\circ}\text{R}$): 6,000

Run Time (milliseconds): 15 to 20